ILLUMINATING ENGINEERING

NOVEMBER, 1950

Electroluminescence — New Method of Producing Light
Part III — Contemporary Lighting in Homes
Shadow and Diffusion in Planned Illumination
Auxiliary Lighting for Museum Galleries
Light Plus Color — A Pick-up for Business
Lighting of Brooklyn-Battery Tunnel

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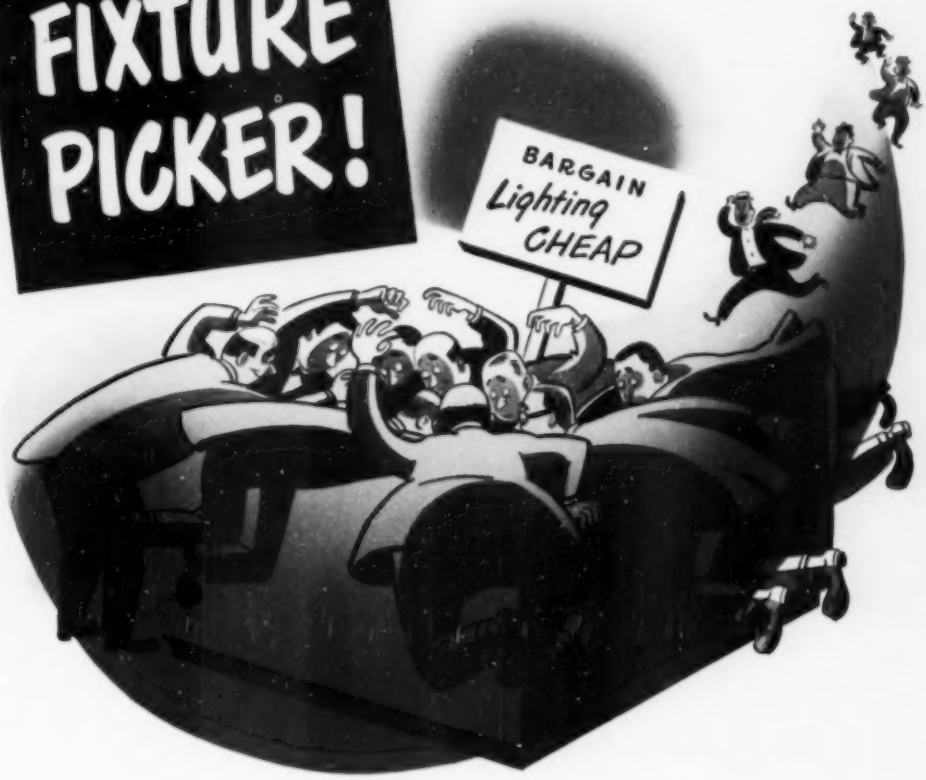

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ILLUMINATING ENGINEERING

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NOVEMBER
1950

Vol. XLV
No. 11

Milliron's — Incandescent Lighting in a Modern Interior 671
Light Plus Color — A Pick-up for Business — Howard Ketcham 673
Auxiliary Lighting for Museum Galleries — Laurence S. Harrison 676
Morale Builders — Light and Paint 680
Lighting Data Sheet — Series XV
Lighting a Reception Room (13-66) 681
What Hinders Shadow and Diffusion from Playing an Adequate Role in the Planning of Illumination? — Dr. Konrad Norden 683
Electroluminescence — A New Method of Producing Light
Elmer C. Payne, Eric L. Mager and Charles W. Jerome 688
Christmas Tricks 694
Lighting Data Sheet — Series XV
Lighting a Small Auditorium-Ballroom (16-7) 695
Lighting of the Brooklyn-Battery Tunnel — Leo Geenens and Kirk M. Reid 697
Lighting Data Sheet — Series XV
Lighting a Store (12-79) 705
Air Port Terminal — Appropriately Modern 707
Contemporary Lighting in Modern and Traditional Interiors — Part III 708
TELECAST — Lighting News of Current Interest 721
Lighting Calendar, 724; Obituary, 726; New Members, 726
Committee Personnel, 1950-1951 727
Miscellaneous Short Items —
Automobile Assembly Plant, Lansing, Mich., 687; Electric Supply Corporation, Chicago, 693
I.E.S. Publications 14A
Index to Advertisers 16A

Sustaining Members — Due to page space limitations, the list of Sustaining Members has been omitted from this issue. For a complete listing, refer to September 1950 issue of ILLUMINATING ENGINEERING, page 598.

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PUBLICATION office 32d Street & Elm Avenue, Baltimore, Md.

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ILLUMINATING ENGINEERING - The Journal of the Illuminating Engineering Society. Copyright 1950 by the Illuminating Engineering Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 14, 1918. ¶Subscription $10 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.50. ¶Address changes must be received at IES headquarters by the first of the month to be effective with the issue of the next succeeding month.

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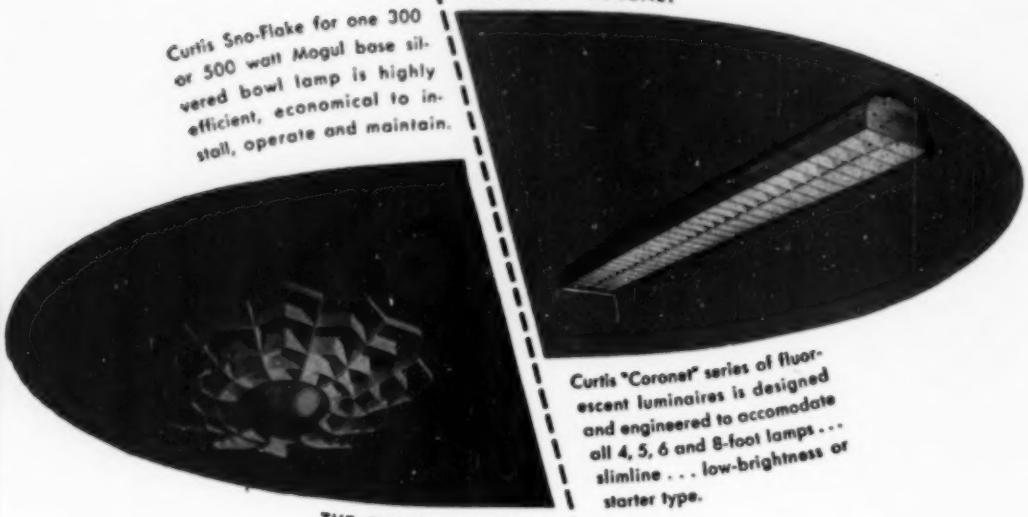

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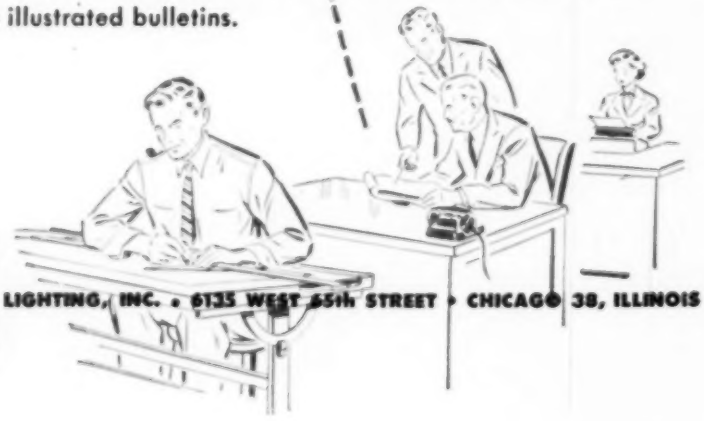

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Milliron's—Incandescent Lighting in a Modern Interior

MORE FREQUENTLY than not, modern interiors are almost synonymous with long lines of fluorescent lighting. In the superbly modern store above, however, the entire first floor is lighted with 650 indirect incandescent units, specially designed by the architects (Gruen and Krummeck).

For Milliron's Westchester, new department store in suburban Los Angeles, an extremely simple lighting system was desired. Milliron's entire selling area is concentrated on one level, 300 by 300 feet in size. However, this area is organized into five separate areas by means of small pylons, these pylons creating the "floors" of the department store. In the center of the store are two escalators leading to and from the roof. This is the main entrance to the store since the parking area is on the roof. Coming down the escalator, the shoppers first enter the "center circle," the area around the base of the escalator, which contains the merchandise ordinarily found on the first floor of a more conventional department store. From there one is guided by color orientation to the Rose Store, for

Specially designed luminaires for the restaurant booths light the individual tables and all surrounding areas.

Lighting data and all photographs are credited to Gruen and Krummeck, Victor Gruen, A.I.A., the designer of the store illustrated, and of the luminaires described.

women's apparel; to the Green Store for the men and boy's department; to the Blue Store for major appliances and furniture; or to the Yellow Store for household goods.

For the lighting, simplicity and economy were achieved with a specially-designed luminaire which features a 42-inch aluminum dome equipped with one 300-watt silver bowl lamp and an aluminum ring which shields the light source from view. Initial cost was low; servicing and maintenance is easy; light distribution is excellent. A level of 60 footcandles is obtained in the area of the light source, with a level of 48 footcandles at mid-point between units (12 per cent variation).

An interesting modern design for incandescent lighting is used also, in the booths of the terrace restaurant on the roof. These are individual table units, shown in the photograph on page 671, which provide sufficient light to make other illumination in that area unnecessary.

Milliron's was heralded by the local press at its opening last year, as "the most modern functionally-designed edifice of its kind in the nation." Similar sentiments might describe its lighting, incandescent notwithstanding.

Light Plus Color—A Pick-up for Business

By HOWARD KETCHAM

MY BUSINESS is to supply color and design styling, and the illumination to go with it, to give a product or store prestige and individual identification, to please the eye, and most important, to attract customers. This service has been applied to over 500 products, and to 58 leading department stores and to some of the leading chain stores in the drug, apparel, footwear, household appliance and food fields. One of the most important elements of this service is to encourage the client's personnel—from the top management down—to feel free to try new and original ideas, mine or their own.

Color can look warm or cold, bright or depressing, gay or sad, pleasing or irritating, refined or crude, wild or tame, exciting or relaxing, clean or dirty, rich or inexpensive; it can make a store appear modern or old-fashioned, appeal to men or women, to the old or to the young, to the smart or the unsophisticated. Used in a store, it should often combine many of these opposite points; sometimes, one department will require one effect, and another should be entirely different.

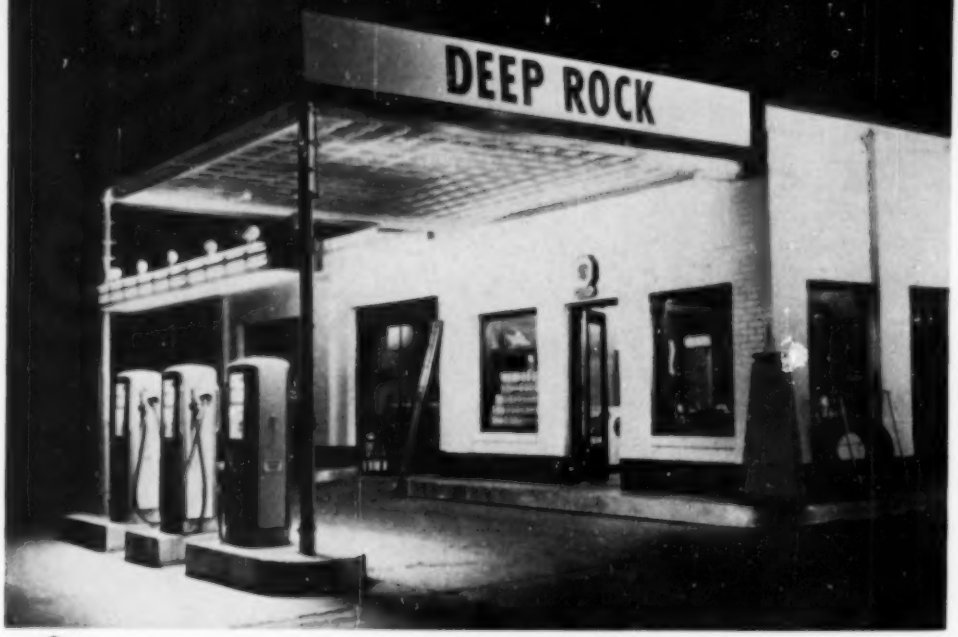
Yet—color lacks of itself size, material, shape or weight. Color cannot be seen without the aid of light. Color is subject to changed appearance under different types and intensities of illumination.

Our public has advanced a long way in the past ten years in its demands on the store operators. Formerly, in a store of normal ceiling height, one could figure on three watts per square foot; today the figure is six watts. In the pre-war years, a store might offer from three to ten footcandles of illumination; now the larger store offers 30 to 40

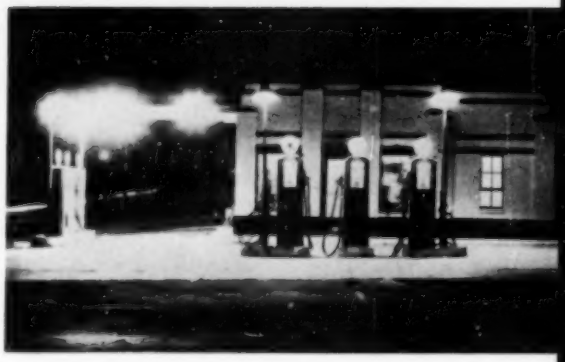
Substance of a talk before the Store Modernization Show panel on Store Lighting and Color, New York City, June, 1949.

Author: Color, design and illumination consultant, New York City, member, Committee on Store Lighting, I.E.S.

Before-and-after photographs of Jersey Central Lines' commuter station at Bayonne show how modern lighting and modern materials complement each other in rehabilitating dingy 75-year-old station. Lowered ceiling permits clean-looking recessed fixture treatment with even spread of diffused light from glass-shielded lines of fluorescent lamps. Ticket window of corrugated aluminum, terrazzo floors and wainscoting, and composition walls replaced gingerbread woodwork, and increased lighting by improvement in light reflection.



At the Deep Rock Oil Corporation station in Tulsa, Okla., where the first unit of Howard Ketcham's new design for service-station illumination was recently installed, lighting values were increased by as much as 10:1 over previous exterior lighting. At the same time, a dramatic accent lighting on the pumps played an important part in the reported 40 per cent sales increase since the station color and lighting renovation.



"Before" picture of the same station shows how glare of old-style service station lighting hits the eye, disturbing motorists. New type lighting decreases glare, removing direct-light-source from line of vision.

footcandles on the main floor, while 20 to 30 footcandles are provided by small stores and in the upper floors of the large store unit.

Today, however, we go beyond a simple measurement of footcandles. We employ color and light to be certain, first, that proper brightness is maintained, and second, that the patron can observe the color of merchandise correctly. One supermarket chain is a firm believer in "sanitary white" walls. The top management also believes in plenty of light, to be sure that the customers can readily read the package labels—which are worth their weight in advertising value. But I know that store managers in that chain, on their own initiative, turn off 50 per cent of the lights because the glare from the white walls is so annoying to patrons. "Cotton in the eyes" is the expression used to describe what happens to the eye when the lighting volume is too great and too completely reflected by the wall colors.

To provide proper brightness without glare, wall color is applied with due consideration of type and amount of lighting. Store operators now appreciate their vital financial stake in providing both the color and the lighting that permit proper appraisal of merchandise. One survey traced 60 per cent of merchandise "returns" to an improper appraisal by the customer of the color and texture of the products, as seen in the store. A Philadelphia department store is said to have cut returns in half with the installation of a modern, color-corrected lighting system.

On the other hand, a successful fur store has boosted sales by providing special booths for view-

TABLE I.—Effects of Lighting on Interior Colors.

	Fluorescent						
	Daylight	4500-deg. White	3500-deg. White	Soft White	Warm Tint	Incandescent	Light Reflectance Efficiency*
Maroon	dull	dull	dull	dull	fair	good	30%
Red	fair	dull	dull	fair	good	good	15%
Pink	fair	fair	fair	fair	good	good	70%
Rust	dull	fair	fair	fair	fair	good	40%
Orange	dull	dull	fair	fair	fair	good	50%
Brown	dull	fair	good	good	fair	good	15%
Tan	dull	fair	good	good	fair	good	60%
Golden Yellow	dull	fair	fair	fair	good	good	60%
Yellow	dull	fair	good	good	dull	fair	75%
Olive	good	fair	fair	fair	brown	brown	10%
Chartreuse	good	good	good	good	yellowed	yellowed	70%
Dark Green	good	good	good	fair	dull	dull	30%
Light Green	good	good	good	fair	dull	dull	75%
Peacock Blue	good	good	dull	dull	dull	dull	8%
Turquoise	good	fair	dull	dull	dull	dull	40%
Royal Blue	good	fair	dull	dull	dull	dull	40%
Light Blue	good	fair	dull	dull	dull	dull	55%
Purple	good	fair	dull	dull	good	dull	10%
Lavender	good	good	dull	dull	good	dull	60%
Magenta	good	good	fair	dull	good	dull	40%
Gray	good	good	fair	soft	soft	dull	55%

*These are approximate figures subject to variation, depending on type of surface or material, finish in painted surfaces, texture of surface, type of illuminant, particular variation of color used, etc.

ing gray, black and brown furs, respectively. The booth for gray furs is lighted with a combination of daylight and 4500K white fluorescent lamps; the booth for black has daylight fluorescents; that used for brown furs has soft-white fluorescents. Each type of lighting enhances the type of merchandise shown.

The question may be raised, Does it pay to change store colors and lighting in today's selling conditions? My only answer is that it pays, if selling merchandise is profitable. One chain store reported that before installing a new interior color and lighting treatment, the store units averaged 40 sales items per hundred shoppers within the store; after restyling the interior, the retail outlets averaged 110 sales per hundred store visitors. In a hardware store, sales went up 40 per cent; in a food store, up 20 per cent; and a service-station chain which called for an integrated color-and-design treatment to provide ready identification for its stations and pumps and packages was able to report increases of 10 to 30 per cent in motor fuel and accessories. It was interesting to read, in the *Reader's Digest*, that sales were up 50 per cent at a premium fuel pump which I spotlighted in color by applying the only touch of red in an otherwise green-and-white station.

Many department stores now split the budget for color and lighting treatment between the building maintenance and operation department and the advertising and display appropriation, because these elements figure so largely in the display program. One store raised its lighting from an average of six footcandles to 45 footcandles, adding proper color treatment. The value of the average sale doubled; merchandise returns were cut from 15 per cent to .05 per cent; and the cost was amortized in two and a half years instead of five.

The problem is to be certain that correlation of color and lighting achieve the effect you are paying for. Walls and other background elements require colors that are cheerful, light-reflectant, and which dramatically set off the merchandise. The wrong color can undo all the selling appeal which has been given the products by the manufacturer.

Today it is often advisable to combine the yellowish light of incandescent fixtures with the blue of fluorescent daylight or 4500K white lamps. In many cases, a combination of 25 per cent incandescent and 75 per cent fluorescent prevails. But the individual problem requires an individual solution. Color and lighting can be used effectively by directing salesmen to show merchandise in certain colors under an incandescent spotlight, and to display the same item in other colors under fluorescent light.

Today it is not enough to pick a color plan which pleases the store president, or his wife, or his secretary. Colors should relate to the practical facts of the merchandise; and in many cases, the best bet is to go to the public. In planning coach colors for the Jersey Central Railroad, four color plans were set up for the commuters to vote on. The railroad management had in mind a favored plan, but the public preferred another—a sea-green and biege, which has been adopted.

The average store operator wouldn't think of doing his own plumbing or dental work, yet a surprising number of executives do feel that they can direct the highly technical problem of selecting proper color and illuminant.

Auxiliary Lighting for Museum Galleries

By LAURENCE S. HARRISON

Experimental studies on what kind of lighting makes art objects look "best" have been underway for the past three years at the Experimental Laboratory of the Metropolitan Museum of Art, New York City. The author, who conducted these experiments in model rooms set up for the study, presents here the first strictly technical report on one result of their program. Some thirty galleries at the Museum, illuminated in accordance with principles developed in the laboratory, are to be rebuilt, two of which are completed and now on view.

ONE OF THE important problems dealt with in the Metropolitan Museum's experimental lighting program was to provide suitable artificial lighting for the thirty sky-lighted paintings galleries which are now about to be modernized. The overall problem also involves certain existing deficiencies in the control of daylight itself. However, this paper deals only with solutions proposed and adopted to harmonize the two different systems of illumination, so that a transition from a solely daylighted to a solely artificially lighted gallery may be pleasing and effective and, in both cases, attractive to visitors.

Natural light, of course, varies widely in both color temperature and intensity and, since this variance must be accepted as the standard for normal visiting hours, there is little basis for pre-

Author: Consulting Engineer, Metropolitan Museum of Art, New York, N. Y.

Figure 1. The gallery in daytime. Whereas the ceiling appears brighter and more uniform in the daytime, the occasional streaks in the center of the ceiling at night (see Fig. 2) are not as noticeable to the eye as they are in the picture.

dicting results when the auxiliary system is used only to reinforce daylight. What can be and has been done is so to relate the two systems as to do the same as is now being done when daylighting needs to be supplemented, but to do it better,—and to provide a fully artificial system which, at darkness, will "stand on its own feet" in terms of the best distribution and quality of light for the purpose.

Natural vs Artificial Quality

The "best quality" was here defined experimentally on the basis of majority opinion among many visitors to the experimental galleries[1]. As was then emphasized, the quality of light must be considered to be quite as important as the level of illumination or as its method of presentation.

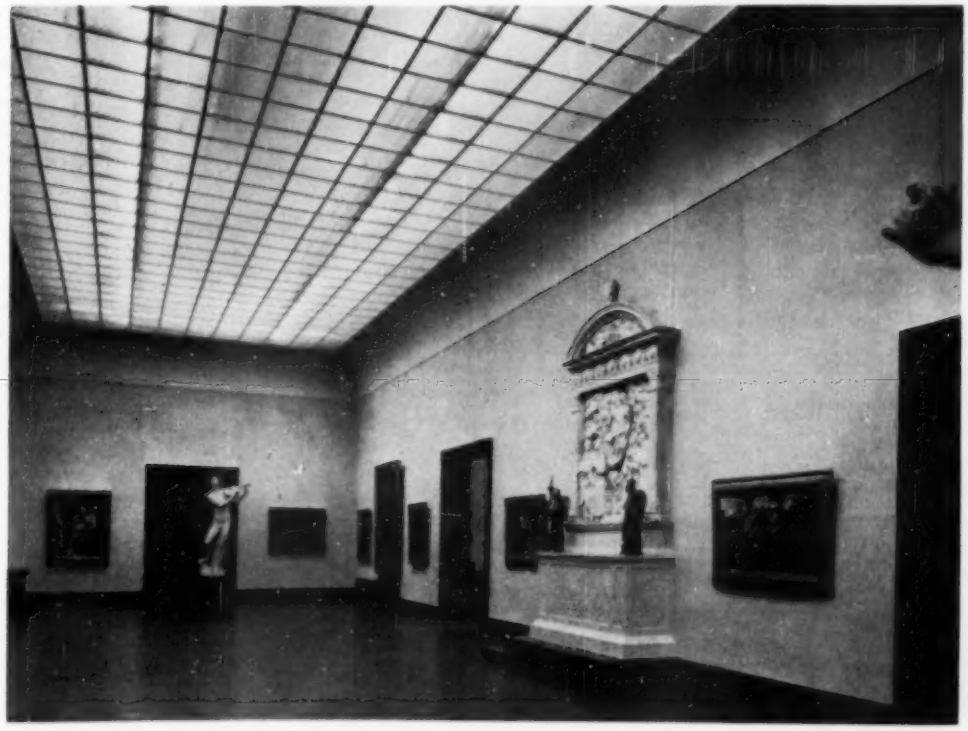
These variations in daylight quality have definite aesthetic significance. Such is clearly observable in color reflectances at different times of day, at different seasons and in different orientations. Moreover, variations in both the color *and intensity* of daylight have, apparently, sufficient psychological advantages as to favor the controlled use of daylight as the ideal source of illumination in areas devoted, as are art museums, to such intangibles as visual "enjoyment."

The foregoing reflects the consensus of a majority as the writer has been able to interpret it. It seems to crystallize a much mooted question, but in justice to the proponents of artificial lighting it must be said that the only honest differences between natural and properly designed artificial lighting, in respect to color and intensity changes, are that such variations are random and unpredictable in one case, while under control and predictable in the other.

To reproduce these changes artificially, if done at all, would be much too costly except on a partial basis in one or two special exhibition galleries, so that the solution to our problem was to establish one pleasing quality. This turned out to be a

[1]See author's article, "Museum Lighting Studied in Laboratory," *Architectural Record*, December, 1948.

Figure 2. The gallery at night. It will be noted that the wall seems to be more brilliantly lighted than the center of the room at night, with the reverse true in daylight. A marked difference in the illumination on the center sculpture is noted between night and daytime, and one sees also the difference in illumination on the ceramic altarpiece in the center of the right-hand wall.



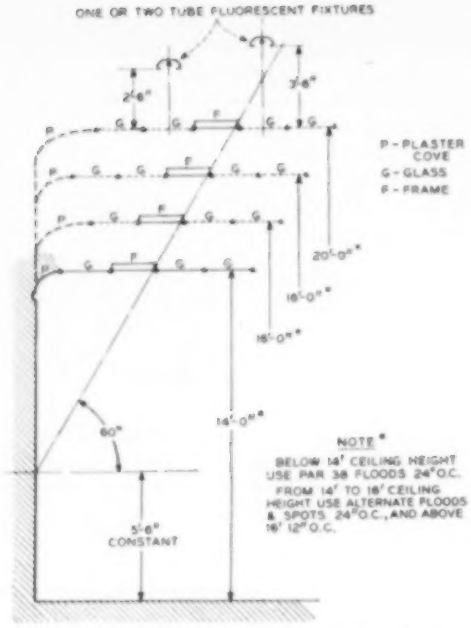

ONE OR TWO TUBE FLUORESCENT FIXTURES
P - PLASTER COVE
G - GLASS
F - FRAME
20'-0"*
18'-0"*
16'-0"*
14'-0"*
60°
5'-6" CONSTANT
NOTE *
BELOW 14' CEILING HEIGHT USE PAR 38 FLOODS 24" O.C.
FROM 14' TO 16' CEILING HEIGHT USE ALTERNATE FLOODS & SPOTS 24" O.C., AND ABOVE 16' 12" O.C.

Figure 3. Wall emphasis lighting, Metropolitan Museum of Art.

combination of incandescent and fluorescent light between 3000K and 4000K, originally composed of 4500K fluorescent enriched by incandescent radiation, let us say, "to taste," but in any case by no less than 25 per cent of the total flux in incandescent lumens on the walls in order to overcome the effect of mercury lines. These limits admit the partial or full use of cool de luxe lamps for the fluorescent component.

Presentation and Working Planes

Paintings galleries are occasionally used to exhibit sculpture, furniture and decorative arts, but the walls constitute the primary working plane. As is well known, the coverage of vertical surfaces at high angles of incidence is costly in watts. These rooms, many with ceiling heights well above eighteen feet, will be provided with a flexible arrangement which permits upper wall coverage entirely or only where needed.

However, the great majority of paintings can be hung within a wall height of ten feet. Consequently, the first requirement is to produce a band of light concentration roughly four to five feet wide and centered about six feet from the floor, running around the four walls. The gallery illustrated is 20 feet 6 inches in height. Wall coverage was accomplished satisfactorily with PAR-38, 150-watt projector lamps, alternatively spots and floods, spaced 12 inches on centers, the spots having the punch necessary to cover the lower band specified and the floods covering the upper part of the wall.

These lamps all project through prismatic panels of water-white tempered glass which provides about a 60-degree horizontal spread to each beam. Fully operated, this system yields about two-thirds of the vertical footcandles on the walls, the remaining third coming from the fluorescent-lighted, central glass

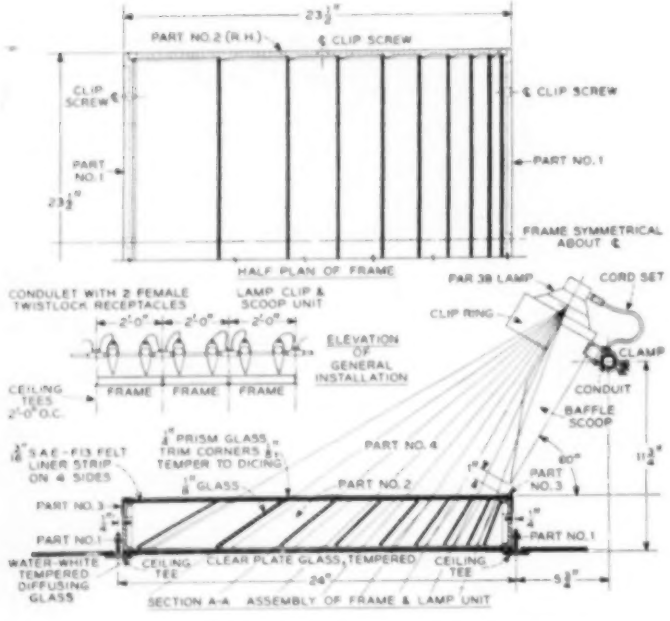


Figure 4. Assembly of equipment for wall emphasis lighting.

field. Over doors, of course, the incandescent fixtures are omitted and if, say on one wall, a large feature painting is arranged with smaller ones on each side, the PAR-38 floods are used only over the central painting.

When the fluorescent light over the central glass field is switched on, an effect is achieved which, from the standpoint of good seeing, rivals any aspect of natural lighting in these areas. This, because daylight, in toplighted galleries, is practically uncontrollable as to direction or selective placement. To minimize the severe shifts of intensity from wall to wall, as the sun changes in azimuth, requires well-designed attic louvering and increased diffusion through ceiling glass. Various forms of attic louvering are being tried, but a new water-white tempered glass has been developed to Metropolitan Museum specifications which, by remarkably soft diffusion, aids the transition from natural to artificial light with advantage to both.

Having adequate daylight on the walls, the effect in the gallery is traditional. It imposes conditions of sight adaptation as does any room with a luminous ceiling. As darkening occurs, the walls, of course, suffer first from diminution of light, although *horizontal* footcandles may be ample until a late hour. The incandescent wall concentration is then switched on, supplementing the waning daylight component. Before blackout of the ceiling glass occurs at night-fall, the fluorescent light is switched on and the artificial system is established.

Wall concentration is presented at an angle of 30 degrees from the vertical, focused on a line on the wall at a height of five feet six inches from the floor. This specification is important. Frame shadows are objectionable. A 30-degree angle will get under most frames without throwing surface reflections from the painting back into viewers' eyes. To maintain this angle, the design of ceiling heights must be related to the location of the steel T-bar sash and of the glass louver frames which operate with the incandescent system. Fig. 3 shows the basis for such layouts.

Finally, the design should be governed by what goes on, optically, in a museum gallery. Here we have the casual visitor, the student, the specialist, the lecture group, the school class, and the copyist. Except for the casual visitor, each usually employs some sort of reference material, such as a catalogue, guide book, note- or sketch-book, canvases on easels, or reference in the person of a guide or lecturer. All of these demand constant transfer of eye focus between the object on the wall and the point of reference.

Now, any given painting may, and usually does, have a number of widely different reflectances in its composition, which alone impose a seeing task of considerable proportions if close optical examination is called for. To assure to all this varied activity a favorable optical "climate," we resort to the simple design requirement on which our entire scheme is based. Stated as a rule, it is that for paintings or other wall-mounted exhibitions the ideal for good seeing requires *the level of illumination on the horizontal working plane to be equal to that on the vertical working plane.*

This simple rule has been verified by many observations and by general acceptance of those who have seen it. The equilibrium thus established between horizontal footcandles in the center of the room and vertical footcandles on the walls is rarely obtained in the daytime and then only with the supplementary incandescent lighting employed. The foregoing is not intended as an argument against daylighting, particularly in a large museum where the entire ground and first floor areas almost entirely lack it, but it does serve the understanding of this problem to say that the aesthetic and psychological advantages of daylight often involve extra cost in optical energy.

It will be noted that little stress has been placed on any fixed level of illumination. The sample galleries both measure 30 footcandles horizontally at four feet six inches from the floor and vertically at five feet six inches from the floor. The same aspects may well be maintained at 20 footcandles, depending on the class of painting and on the wall finish. The rooms referred to prefer medium warm gray on the walls, but best results will be obtained by holding the brightness contrast between the painting and its surround as low as possible and in favor of the painting.

The assembly of fixtures is illustrated in Fig. 4. The scoop-shade serves to prevent spill-over of incandescent light onto the adjacent ceiling glass, confining it to the low-brightness behavior of the louver frame and assuring a good cut-off at the floor line. The latter is of primary importance, as is a dark floor. At the concentrations here specified, high floor brightness may seriously unbalance the effect produced.

The louver frames are fitted with glass vanes, which are kept clean over long periods by being enclosed in glass. The fluorescent fixtures are single or two-lamp, 40-watt, instant start industrial units in continuous rows, arranged concentrically in two "rectangular" runs around the ceiling field of wider galleries, and in parallel rows in narrower rooms. At the 20-foot 6-inch ceiling heights, the results described require from 10 to 14 watts per square foot of floor area, depending on the coverage required on the upper walls.

In relighting these sub-station rooms, the main objective was to improve the working conditions of the personnel — whose operations, reading meters hourly — are at best monotonous. The goal was 20 footcandles without glare. The limitations were: utilizing present outlets for economy's sake; close-ceiling mounting; a resistance to recoloring the boards. In the St. Louis station above left, concentric ring luminaires with 300-watt silver-bowl lamps, on 9-foot centers, meet these objectives, at the same time reducing bright reflections on the face of the meters. Since lighting alone may not make a working interior comfortable, light flat pastel shades have replaced the uninteresting glossy buff walls shown in the "before" picture at right. All photographs and data from Louis E. Mueller, Detroit Edison Co.

Morale Builders—*Light and Paint*

Below right, is a front view of the switchboard room of the Orchard Station before modernization. The picture at left is a view back of the board taken after it was relighted and painted. The pipe supports have all been painted a very light pastel green with a matte finish. Objective — morale building — has been met.

Lighting a Reception Room

LIGHTING OBJECTIVE: To provide illumination for secretarial typing and casual reading (by visitors) in keeping with the decorative design of the room.

Installation at Oklahoma Natural Gas Company, Tulsa, Oklahoma

General Information: The room is 22'2" x 8'11" with a 12' ceiling. Surface characteristics are as follows:

Area	*Color*	*Munsell Notation*	*Reflectance*
Actual Ceiling	White	N 9.6/	81.0%
Luminous Ceiling	White	N 9.6/	80.0
Louver Beams	Blue	B 5.5/6	28.0
North Wall Paneling	Brown	YR 4/3	13.5
South Wall (plaster)	Tan	Y 7/2	46.0
Carpeting	Red	R 3/6	6.0
Desk Top	Brown	YR 3/6	13.5
Desk Blotter	Brown	YR 4/4	10.0
Curtain (average)	Green	GBG 5/8 GY 7/1 N 9.6/	45.0
Sofa	Yellow	Y 7/6	30.0

(over)

A.I.A. File No. 31/14

The receptionist does secretarial typing and proofreading at the desk, and visitors seated on the sofa read magazines.

Installation: Bare 40-watt 4500K fluorescent lamps are mounted on the ceiling, 2'9" above a translucent Plexiglass ceiling hung 9' above the floor. Twenty-two lamps are employed in all, spaced 1' apart over the desk area and 1'9" throughout the rest of the room. The Plexiglass is supported by wooden beams 1" thick which form louver cells 1'4⅝" x 2'2¾" x 4". Supplementary desk illumination is provided by an 18-inch high table lamp containing three 60-watt filament lamps.

Illumination and brightness measurements are as follows:

Illumination (footcandles)

	Sofa	*Desk*
Horizontal	42	52
45 Degree Plane	20	30

Brightness (footlamberts)
(from position seated at desk)

Ceiling	
Plexiglass Panel (40°)	150
Vertical Side of Louvers	17
Underside of Louvers	6
Wall	
Paneling	2
Plaster	7
Floor	1
Desk	
Wood Top	14
Blotter	7
Drapery	4
Sofa	9
Table Lamp Shade	
(inside—viewed from standing position)	320

Lighting data submitted by Dale H. Watt, Watt Plumbing, Air Conditioning and Electric Co., Tulsa, Oklahoma as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society
51 Madison Avenue, New York 10, N. Y.

What Hinders Shadow and Diffusion from Playing an Adequate Role in the Planning of Illumination?

By DR. KONRAD NORDEN

SINCE Charles P. Steinmetz forty years ago in his classical book "Radiation, Light and Illumination" proclaimed the study of the shadows as "one of the most important subjects of illuminating engineering," there has been general consensus regarding the necessity of their proper treatment. This holds not only for distracting or objectionable shadows which should be eliminated or at least minimized, but no less for revealing or beneficial shadows, the control of which affords an important means of improving the contrasts, hence the visibility.[1] Every Code, Standard, or Recommended Practice of lighting pays respects to shadow and diffusion as criteria of good lighting. Yet, the illuminating engineer computes the intensity levels and, if he is quite up-to-date, also checks the resultant brightness ratios, but lets the shadows take care of themselves. For this, he cannot be blamed, for no guidance offered to him with regard to shadows is stated in quantitative terms.[2]

This paper proposes to examine which numerical data are missing and how they can be procured to bring the treatment of shadows eventually within the reach of the planning engineer. Any such treatment should, of course, be subsequent to the layout of the intensity levels.

The ideal procedure which the engineer would follow in taking care of the shadows is given below. Since shadow problems are important in industrial lighting, the study shall mainly refer to that field.

First Step. Decide upon the upper and lower shadow factor required for the kind of work in question.

Second Step. Ascertain maximum and minimum values of the shadowed illumination from suitable curves of the proposed lighting equipment.

Third Step. Divide either value by the planned mean illumination and compare the two resulting shadow factors respectively with the upper and lower factor decided in step 1.

Fourth Step. (Conditional only) If the required limits are exceeded, modify your lay-out accordingly, until adjustment is achieved.

Discussion of the Above Steps

1. Deciding upon the shadow factors required for the kind of work.

Prerequisite to this decision is the existence of recommended standards of shadow factors for industrial interiors. Such tables do not exist, or at least never got beyond feeble starts.[3] To establish them, a proper committee could study the criteria of admissible distracting and desirable revealing shadows, and determine upper and lower limits of the shadow-factor limits according to the needs of specific industries. Shadow factor is numerically defined by $S = \frac{E_s}{E} = \frac{E - E_r}{E}$, where E represents the unshaded, E_s the shadowed illumination (*i.e.* that obstructed by the caster) and E_r the residue illumination in the shadow; a certain range or value may be objectionable in one case and beneficial in another. The complementary term $\frac{E_r}{E} = D$ represents the diffusion factor.

Examples of shadow-factor ranges for industrial processes are shown on the following page:

[1] The definition of the two kinds of shadows will be found in the author's book "Shadow and Diffusion in Illuminating Engineering." Pitman & Sons, London, 1948.

[2] The scarce references to shadow treatment deal almost exclusively with objectionable shadows, see e.g. Recommended Practice of Office Lighting, 1947, 333; 522; 6.3, American Standard Practice for School Lighting, 1948, 2.23 etc. The only mention of revealing shadows, was found in Recommended Practice of Industrial Lighting under "Diffusion and Distribution of Light," p 19 of the Reprint, 1942.

Author: Sudeletro, S. A., Rio de Janeiro, Brazil.

[3] Previous attempts to establish tables of appropriate shadow factors are summarized in the book "Shadow and Diffusion in Illuminating Engineering," page 129/30. In the Russian Code of Artificial Lighting for Factories etc. of 1928 the maximum sh.f. admitted on workplaces is 0.8, but this limitation does not apply if the residue illumination exceeds 100 lux for processes of any degree of fineness, or 25 lux for medium work; if the shadows are moving, the limit is lowered to 0.4. There are also limits fixed for gangways, staircases and passageways within the building, as well as for courtyards. How far these rules are based on measurements is not known.

The author has attempted to arrive at certain factors by computation, taking into account physiological (contrast induction) and psychological elements (color constancy) implicit in the act of seeing shadows and affecting the quality of shadowed colors. This method, apart from giving a remarkable insight into the nature of shadows, has yielded certain numerical results regarding objectionable shadows.

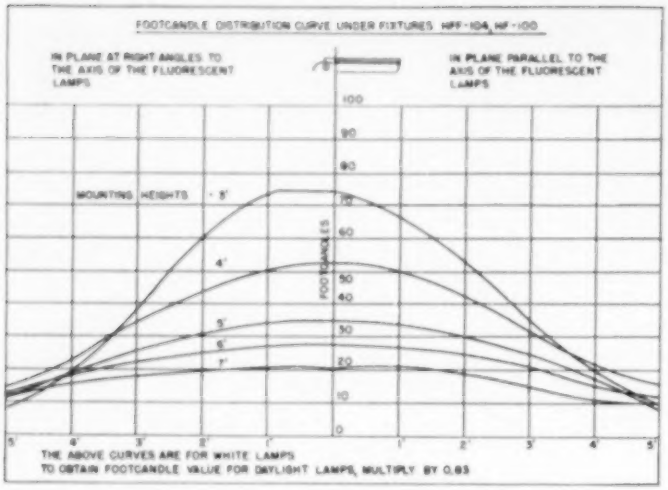


Figure 1. Footcandle curves of 100-watt Miralume HF-100 at various mounting heights, plotted against distances from below the center of the luminaire. (Courtesy of Sylvania Electric Products Inc.)

Figure 2. Footcandle measurements of 200-watt incandescent lamp in 16-inch Porcelain-enameled RLM Dome Reflector at three mounting heights.

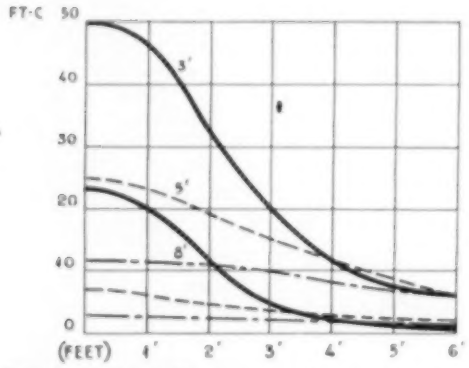
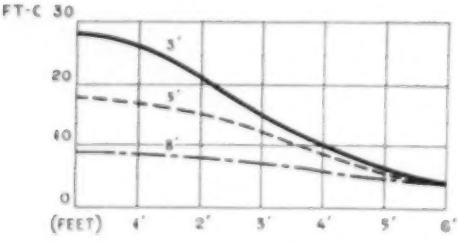


Figure 2a. (Above) The upper curve for each height represents the unshaded illumination E; the lower curve the residue illumination E_r when the shadow caster is applied.

Figure 2b (Below) shows the differential values $E - E_r = E_s$ (shadowed illumination), plotted from 2a.



Process	High shadow factor useful for:
Type setting	bringing the type out in relief
Inspection of non-specular material	revealing pits, scratches and cracks
Grading matte material according to roughness of surface, e.g. writing or drawing paper	modelling the minute surface elevations and depressions of the surface
File cutting	deepening the grooves
"Make-ready" on machine before printing	making recognizable unequal impressions of the form on the paper

Process	Low shadow factor useful for:
Drafting boards	recognizing the fine marks left by the points of compasses, also for making the latter stand out in relief against white paper
Inspection of plated metal parts	bringing out defects due to inadequate plating or exposures of the base metal, which appear as color differences
Inspection of polished metal plates	detecting various blemishes such as small cuts, scratches or abrasions on the glossy surfaces
Inspection of razor blades	"
Inspection of roller bearings	"
Inspection of glossy black leather	"

Some processes have recently been treated in the Report "Lighting for the Machining of Small Metal Parts" (see ILLUMINATING ENGINEERING October, 1949), where the visibility is concurrently influenced by brightness and by shadow and diffusion. This study which so thoroughly deals with the effects of brightness, should one day be supplied with a parallel analysis of the effects of shadow and diffusion factors which will further elucidate the problems involved.

2. *Ascertaining maximum and minimum values of the shadowed illumination from curves of the proposed light source.*

Once the desired S_{max} and S_{min} factors have been determined, the engineer can appraise the inherent ability of the planned lighting system to produce them. This involves a study of maximum and minimum shadowed illumination from tables or diagrams based on specific equipment types, and given spacing-mounting height relationships. Footcandle curves of unshaded illumination can be found in the catalogs of some manufacturers (see Fig. 1), but these curves consider the room as absolutely black and are incommensurate with illumination levels computed in the usual way.[4] This difficulty does not exist with regard to E_s curves: although produced by successive measurements of E and then, with the caster interposed, of E_r, the subtraction $E - E_r = E_s$, leaves E_s as an inherent feature of the luminaire per se. Figs. 2 and 3 show measurements by the author with a standard caster and a Weston 614 photo-electric meter.

To make shadow measurements directly comparable with each other, one standard caster must be used in combination with the measuring instrument. This standard caster[5] measures the potential shadows inherent to the light source and eliminates the variability of the operative casters more typical

[4]The author suggests that the curves be taken in a room of well defined dimensions and reflection coefficients. The maintenance factor can be included by plotting a new set of parallel curves. To adjust these curves to any given room, their ordinates could be reduced in proportion of the respective room indices and coefficients of utilization. Prof. Perry Moon's "Inter-reflection Method of Lighting Design" supposedly makes possible illumination calculations at any point in the room but this method is certainly not meant for daily engineering work.

[5]See concluding Chapter V of "Shadow and Diffusion in Illuminating Engineering," p. 113.

Figure 3. Footcandle measurements of RLM 48" Fluorescent three-lamp open-end porcelain-enamel unit at 3 mounting heights.

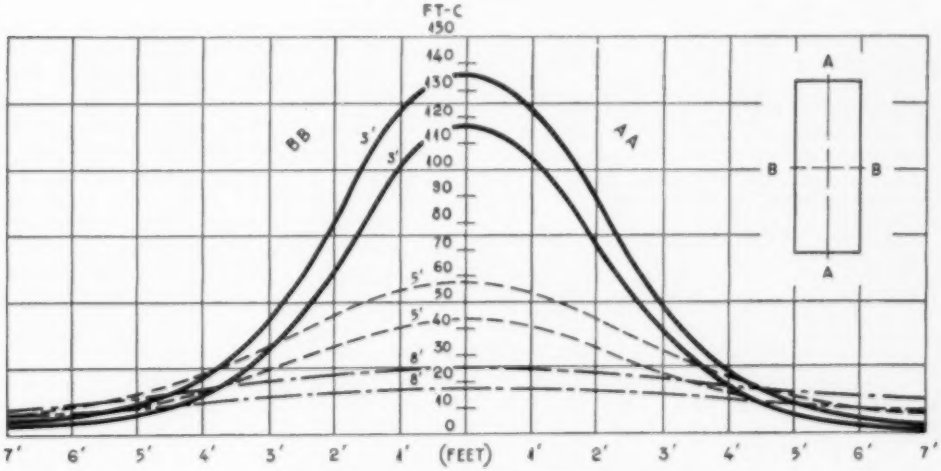
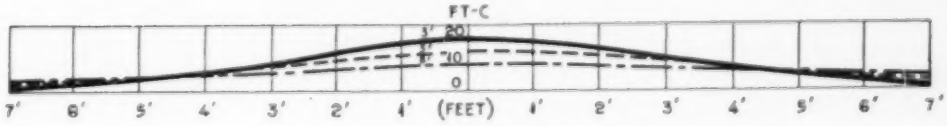


Figure 3a. (Above) Analogous to Fig. 2a.

Figure 3b. (Below) Analogous to Fig. 2b.



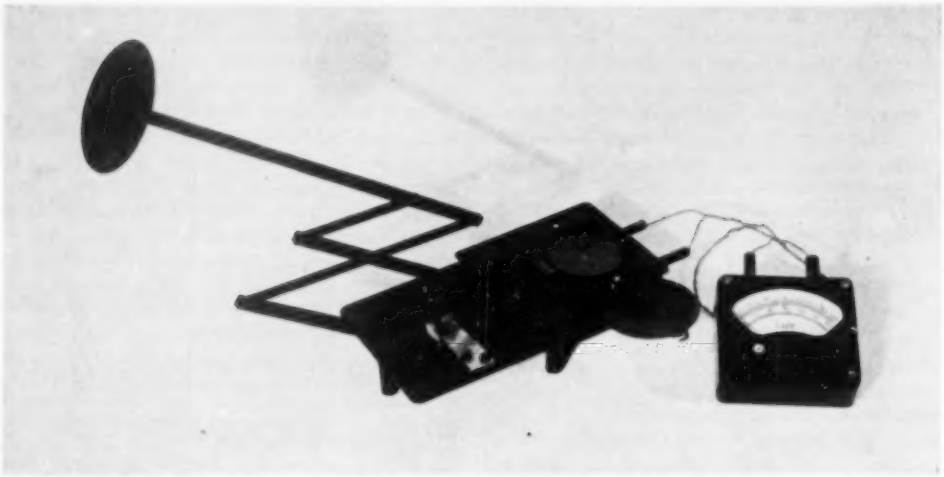


Figure 4 Standard shadow caster with photo-electric cell inserted. Instead of the metering arrangement shown, any conventional photo-electric meter can be used (see ILLUMINATING ENGINEERING, Oct. 1949, p. 608).

of practical obstructions. The standard-caster mechanism automatically maintains its distance from the center of the photo-electric cell as seen in Fig. 4.

With the E_s diagrams of the planned light source, the engineer can select maximum and minimum E_s values. The maximum comes directly beneath a light source or very close to that point, and the minimum is half way between the two sources. E_s values are not, as are E values, resultants from the overlapping fluxes of two or more contributing sources, since systematic shadowing deals with the single light source eclipsed by the caster. The shadow produced by a certain source I decreases with distance until a second source II becomes closer.

The engineer gets the maximum E_s from the respective E_s curve at or close to abcissa O, and the value at an abscissa equal to the greatest half-way distance between two outlets for minimum E_s. If the actual layout provides a mounting height of five feet above the work plane and a maximum spacing of six feet, values are given in Table I.

3. Dividing either value by that of the planned mean illumination and comparing the two resulting shadow factors respectively to the desired upper and lower factor.

To determine the unshaded illumination E, the engineer must use the *mean* illumination on which he has based his layout. With closely spaced continuous row or louverall installations, there is practically uniform illumination throughout the room. In other modern installations, the illumination is also fairly uniform. Recommended values of illumination or shadow factors are, of course, not a matter of high precision, and allowance must be made for some variation. By recommending lower values of recommended S_{max} or upper values of recommended S_{min}, opposite errors can compensate.

Under these circumstances, mean illumination E_m is justified as the denominator of S. The maintenance factor contained in the computed value of E_m, must still be applied to the E_s values as indicated in Table I.

TABLE I.

For the fixture with	according to Fig.	$(E_s)_{max}$ measured	$(E_s)_{max}$ reduced*	$(E_s)_{min}$ measured	$(E_s)_{min}$ reduced*
Incandescent 200 w. lamp	2	17	11	3	2
Fluorescent 3x40 w. lamp	3	14	10	4	2.8
If the case is one of essentially local lighting, with 3' above the work plane and 4' spacing, we get					
Incandescent as above	2	34	22	5.5	3.6
Fluorescent as above	3	20	14	7	4.9

*Reduced by maintenance factor of 0.65 applied to Fig. 2 and 0.70 to Fig. 3.

4. Modifying the layout if shadow factors are outside desired limits.

If the procedure is necessary, the illuminating engineer should first try to vary either the spacing or the mounting height; if this does not give satisfactory results, the selection of a more or a less diffusing type of luminaire will be the choice. There will be no difficulty in adjusting the layout to the requirements of sound shadow-engineering.

Conclusion

An engineering treatment of shadows in a practical layout, anticipates the availability of

1. tables of recommended ranges of shadow factors.

2. diagrams of the shadowed illumination produced by the usual light sources at various mounting heights and spacings.

Both are far from being inaccessible. The writer feels that No. 1 could easily be achieved if entrusted to a Committee of I.E.S. No. 2 should be left to fixture manufacturers who, under the guidance of the I.E.S. could measure the E_s values of their current types for publication in their catalogs.[6] In this respect it is encouraging to note how soon the data on brightness have found their way into the publicity of leading fixture manufacturers.

A British reviewer has questioned the calculation of shadow factor by the lighting engineer "as a necessary further complication of his already complex task." This is an appeal to indolence. Once a new avenue is opened towards better lighting, it does not rest with us whether we shall exploit or abandon it. We simply cannot afford to frustrate progress.

[6] It is suggested that the matter be included in the "IES Guides to Testing Procedures."

Automobile Assembly Plant

A maintained average illumination level of 47 footcandles is achieved at the Oldsmobile Division plant of General Motors Corp., at Lansing, Michigan. Industrial lighting units in 88 continuous rows, two rows per 18-foot bay, are mounted 10 feet high on approximately 9-foot spacing between rows. Two 96-inch T-12 slimline lamps, 3500K, are employed in each unit. The photograph was taken from approximately the center of the floor area. Total lighted area is 126,000 square feet (approximately 794 ft by 160 ft).

Electroluminescence—
A New Method of Producing Light

By ELMER C. PAYNE
ERIC L. MAGER and CHARLES W. JEROME

Certain compounds luminesce when placed in a fluctuating electric field. This constitutes a new approach to the problem of "cold light." This phenomenon of electroluminescence is discussed in some detail. Experiments are described which reveal some of the more important aspects of this method in which light appears to be produced by direct transformation of electrical energy into visible radiation. Methods of utilizing electroluminescence have been developed which permit its use in several practical applications.

THE TRANSFORMATION of one form of energy into another, including ways and means of accomplishing this task simply and directly is of major engineering importance. One of the most interesting and important transformations is that of power inot light. Historically the first and still the most widely used method of generating light depends upon the phenomenon of incandescence. Another method of considerable practical importance involves the excitation of resonance and other radiations by the passage of an electric current through a gas or vapor. This second method may also include the phenomenon of the fluorescence of solids exposed to these radiations.

A third method of converting energy into light has been the subject of considerable study in our laboratories. This method involves neither incandescent nor gaseous discharge phenomena.

The Phenomenon of Electroluminescence

When certain materials are placed in a fluctuating electric field under proper conditions, they are excited to luminescence and continue to emit light as long as the exciting field is maintained. This constitutes the phenomenon of *electroluminescence* (not to be confused with cathodoluminescence). No intermediate phenomenon such as a glow or arc discharge appears to be involved. The materials luminesce directly under the influence of the electric field which must, however, be in the process of changing in intensity. Since this apparently is a direct transformation of electrical energy into light, a new field of study is revealed which offers intriguing possibilities from both theoretical and practical standpoints.

This phenomenon has been described by Destriau[1] and discussed more recently by Leverenz[2] whose experience with the phenomenon appears to have been rather discouraging.

This paper reports some of the results we have obtained with this phenomenon which leave no doubt regarding its existence. In fact, light intensities have been achieved which are adequate for many practical applications.

Electroluminescence may be produced through a device which comprises a film of phosphor dispersed in a dielectric and placed between two conducting plates. At least one of these plates preferably should be light transmitting in order for the light generated to emerge. Such a device may be regarded as a luminous capacitor.

The Luminous Capacitor and its Characteristics

A type of luminous capacitor which gives sufficient luminosity for many purposes at relatively low a-c potentials has been developed in these laboratories.

The general construction of the Luminous Capacitor which has been used in much of our work is illustrated in Fig. 1. A coating of phosphor suspended in a suitable solid dielectric is spread uniformly over the conducting surface of so-called "conducting glass." The surface of the phosphor-dielectric film is then coated with a metallic conductor, except for a narrow strip around the edge of the plaque. One effective method of applying this metallic film is to coat the dielectric with vaporized aluminum. Suitable connections are then made to a contact strip along one edge of the conducting glass and to any convenient spot on the metallic backing layer.

A number of substances have been found which can be excited to a greater or lesser degree in this device. Some are also fluorescent under ultra-

A paper presented at the National Technical Conference of the Illuminating Engineering Society, August 21-24, 1950, Pasadena, California. Authors: Sylvania Electric Products Inc., Salem, Mass.

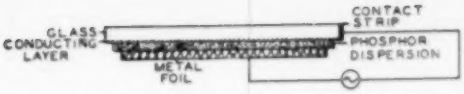


Figure 1. Diagram showing construction of luminescent (condenser) lamp.

violet or cathode ray excitation, some are phosphorescent, and some are neither. No direct correlation has been observed between the luminescence of a phosphor excited by the electric field and that resulting from ultraviolet or cathode ray excitation.

It has been stated above that the emission of light in this manner is contingent upon a fluctuating field intensity. A brief flash of light may be observed when a d-c potential is applied to the plaque of Fig. 1 and another when the charge is permitted to leak off, but no light at all is emitted as long as the d-c potential is maintained. A graphic way of demonstrating this behavior is shown in Fig. 2. In this experiment the output of a square wave generator was applied to the plaque terminals. Simultaneous cathode ray tube graphs were taken of the applied voltage and of the light emitted. It is obvious that luminescence occurs when the potential is changing. Short bursts of light are emitted which are practically in phase with the voltage changes at the end of each half cycle.

Similar tests were run using a 60-cycle sine wave source of supply. In these tests, it was possible to determine with considerable accuracy the phase relationships between voltage, current, and luminescence. Fig. 3 is a graph which demonstrates the fact that the light emitted is in phase with the power absorbed by the dielectric. It is apparent that the current leads the voltage by nearly 90°. Most of the luminescence occurs when both voltage and current are in the same direction although in different quadrants. This of course is the period when the capacitor is absorbing energy. Very little light is emitted when voltage and current are in opposite directions. In other words, the light emission is in phase with the positive half of the power curve.

Several factors affect the intensity of the light emitted. The thickness, the resistivity, and the dielectric constant of the phosphor layer are all

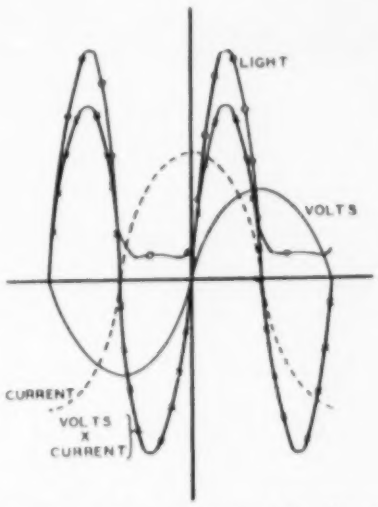


Figure 3. Curves showing the phase relationships of light output, voltage, current, and voltamperes.

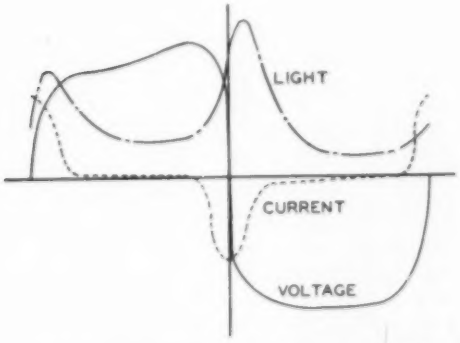


Figure 2. Curves showing how the light output of a luminescent (condenser) lamp depends upon rate of change of voltage.

important, as are the voltage and frequency at which the device is operated.

Fig. 4 illustrates the relation between light output and voltage for a typical luminous capacitor operated at 60 cycles per second. The threshold of visibility is at a potential of the order of 25 volts. The brightness of the lamp increases rapidly with the voltage over a considerable range of potential until a limiting voltage is reached. This limiting potential is that at which breakdown of the dielectric occurs.

At a given voltage the light output increases with frequency as shown in Fig. 5, Curve A. In the test upon which Fig. 5 is based, a variable frequency generator was connected to the conducting plates of the lamp and a constant voltage of 100 volts was applied. The light output was measured as the frequency was varied between 50

and 3500 cycles per second. There is some discrepancy to be accounted for in the neighborhood of 50 cycles, possibly due to some resonance effect in the generating equipment, but with this exception the light output increases with frequency. Curve B of this figure is of equal interest and of some theoretical significance. This curve shows the relation between light output and wattage consumption at different frequencies. The linearity of this relation over nearly the whole range of frequencies suggests that a given amount of light is emitted each time the capacitor lamp is charged to a given potential or, in other words, each time a given quantity of electricity is stored in the capacitor lamp. The more times per second this is accomplished, the more light will be emitted. This, of course, agrees well with quantum considerations.

These results differ from those reported by Leverenz[2] who performed some experiments with phosphor films furnished him by Destriau[1] as well as with phosphor films prepared in his own laboratories. He states that these films were found to glow feebly blue (barely perceptible to the partially dark-adapted eye) under applied 110-volt alternating current. Leverenz believes that this glow is that characteristic of breakdown ionization of atmospheric nitrogen on the assumption that the electric field may produce a breakdown of thin air films surrounding the phosphor particles in the organic film.

Whatever may have been the situation in the experiments performed by Leverenz, the results which we have obtained prove that his conclusions are not applicable to the devices described here.

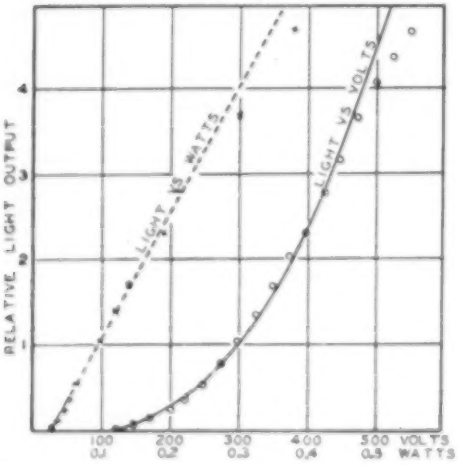


Figure 4. Curves showing variation of light output with voltage and wattage for a luminescent lamp.

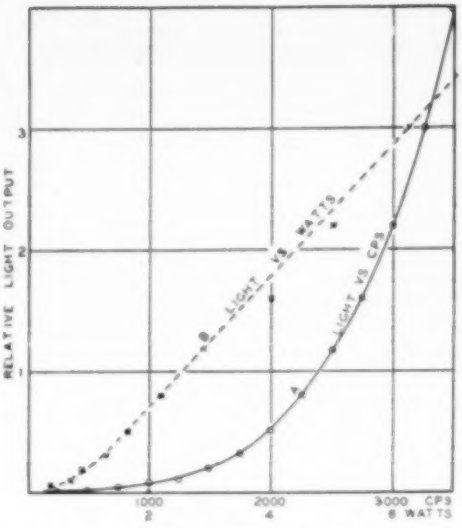


Figure 5. Curves showing variation of light output with frequency and wattage consumed.

If the light obtained from our lamps were associated with glow discharge phenomena, it should be even more intense on d-c than on a-c whereas there is no light emitted at all on sustained d-c potentials of the same value as the a-c voltages used. All phosphors capable of being excited by ultraviolet should emit some light of their characteristic color. Only certain phosphors exhibit electroluminescence. If glow discharge phenomena were responsible, the luminosity should be in phase with the current. It definitely is not. The lack of a glow discharge in these lamps is also evident from the fact that the current leads the voltage by a large phase angle. Furthermore, the higher the dielectric constant and resistivity of the medium in which the phosphors are embedded, the greater the light intensity at a given voltage or, conversely, the lower the voltage at which a given luminosity may be obtained.

An explanation has been advanced by Garlick[3] that light emitted under field excitation is a phosphorescence resulting from the lifting of electrons from deep traps. This explanation may have some theoretical merit although it seems rather difficult to visualize in view of the fact that in some of our experiments lamps which had been kept in complete darkness for as long as three days luminesced at normal brilliance immediately upon application of the proper voltage. Other luminescent (condenser) lamps have been operated continuously in a light-tight box for as much as 16 hours with no appre-

ciable diminution of their light output. In this latter case, the phosphorescence must have been self-excited if the explanation referred to is accepted.

Examples

Fig. 6 is a photograph of a luminous capacitor and its surroundings. The photograph was taken in a dark room with the light generated by the lamp itself. The brightness of the source was about three footlamberts. The exposure time and development were adjusted to give a close representation of the visual appearance of the plaque and surround under the conditions at the time the photograph was taken.

Another type of device which demonstrates the phenomenon of electroluminescence is shown in Fig. 7. Here again the device was photographed by its own light. The scheme for making the demonstration piece was very simple. A pair of enameled copper wires were wound side by side in close physical contact on a glass tube. The phosphor suspended in an insulating oil was brushed over the wire wound tube. When an a-c potential of 200 volts or thereabouts was applied to the ends of the two wires luminescence was produced. The luminescence produced in this way corresponds in every respect to that obtained with the luminous capacitor. Only certain phosphors are effective, alternating or pulsating fields must be used and the luminosity is a function of the voltage and the frequency.

The useful life to be expected from these lamps has not yet been fully determined although some

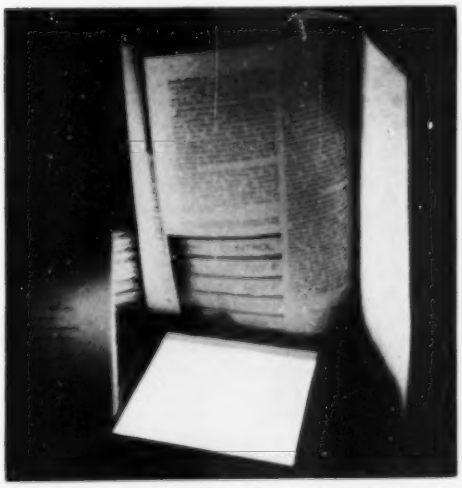


Figure 6. A luminescent (condenser) lamp and its surround photographed in a dark room by its own light.

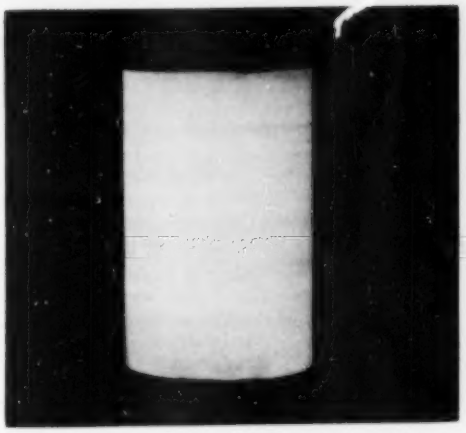


Figure 7. A wire-wound grid type of luminescent lamp photographed by its own light.

of them have now been in operation for some thousands of hours. After about 50 hours of operation, their light output seems to flatten off and remain fairly constant over considerable periods. Further data on both points are being accumulated.

The characteristics of this new light source are ideal for its use as a luminous ceiling where the lamps are mounted much in the fashion of acoustic tile and a broad, uniform low-brightness source of illumination is obtained. Since a surface brightness of as much as 20 footlamberts has been obtained under certain conditions, luminous ceilings constructed in some such fashion would be quite practical.

For other applications luminescent (condenser) lamps of lesser brightness are quite satisfactory. A few self-illuminated instances of these applications are shown in the remaining illustrations.

Fig. 8 shows how readily visible a wall switch is when one of these new lamps is used for the coverplate. All that is required in this application is to connect the lamp in parallel with the switch. When the switch is open the lamp is lighted but draws a negligible current.

The illuminated clock dial is another application of the luminescent type of lamp. Such a dial is shown in Fig. 9. Many other similar applications suggest themselves. Radio and television dials, automobile dashboards and airplane cockpit illumination are some of those most readily recognized. The fact that this lamp may be easily and smoothly dimmed to extinction simply by varying the applied voltage, and the fact that it operates instantaneously upon application of the required potential are definite points in its favor.

It is interesting to note that no perceptible color change takes place on dimming but that a very definite color change has been observed with variable frequency operation. For example, a luminescent (condenser) lamp which luminesced in the yellow green at 60 cycles had a pale blue-green color at 3000 cycles. No explanation for this behavior is advanced although it may well be due to different decay rates of the phosphor components.

Summary

The phenomenon of electroluminescence presents a new approach to the problem of producing light. In this phenomenon certain phosphors are excited to luminescence when subjected to fluctuating electric fields. It has been found that the light emitted under these conditions is in phase with and proportional to the wattage consumed by the luminescent dielectric.

The light emitted varies with the applied voltage and with its a-c frequency. A practical device for generating and utilizing electroluminescence has been developed.

Several practical applications of the phenomenon are described.

Acknowledgments

The authors wish to express their appreciation to Mr. Howard Biggs, Chief Engineer of the Lighting Division for his support and continuing interest and to Dr. E. F. Lowry who has been intimately connected with the project. They also wish to thank the Corning Glass Company for furnishing samples of conducting glass which have been used in this investigation.

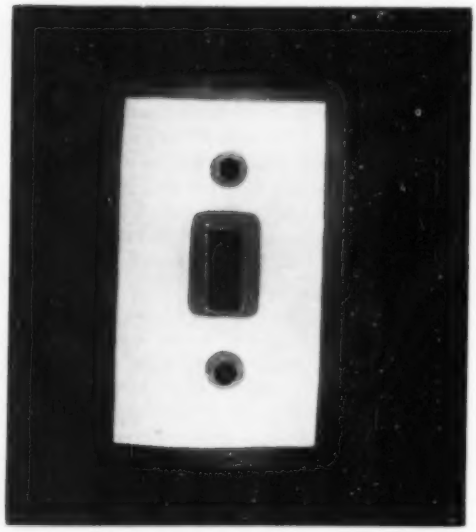


Figure 8. A luminescent (condenser) lamp in the form of a switch plate, photographed by its own light

Figure 9. A luminescent (condenser) lamp in the form of an illuminated clockface, photographed by its own light.

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1. Destriau, G., "Sur les Scintillations des Sulfures de Zinc aux Rayons Alpha," *Journal de Chimie Physique*, Vol. 33, p. 620 (1936). Destriau, G., "The New Phenomenon of Electrophotoluminescence and its Possibilities for the Investigation of Crystal Lattice," *Philosophical Magazine*, Vol. 38, p. 700 (Oct. 1947).

2. Leverenz, H. W., "An Introduction to Luminescence of Solids," John Wiley & Sons, New York, 1950, p. 392.

3. Garlick, G. F. J., "Luminescent Materials," Oxford University Press, London, 1949, p. 145.

DISCUSSION

DR. E. G. F. ARNOTT*: This paper presents a very interesting study of the phenomenon of electroluminescence as well as some of the practical applications. Some work done in this laboratory also indicates that the earlier statements regarding this process are not generally true for all electroluminescent substances. We would be interested in an explanation of the authors' curve showing the rapid increase in light output versus frequency with constant applied voltage; also in any information on the variation in efficiency as a function of dielectric constant and resistivity of the phosphor suspension medium and of temperature.

With zinc sulphide we have not been able to observe a flash of light on the removal of a d-c voltage and wonder

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if this is peculiar to the phosphor or to the dielectric materials. While this source of illumination has low brightness, it is surprising to find that as high a value as 20 footlamberts has been obtained. What voltage and frequency were required for this brightness? Also, what voltage and frequency were applied to the cells which have been operating for thousands of hours?

W. W. Shaver*: This paper by Messrs. Payne, Mager, and Jerome which Dr. Lowry has just presented seems to open up a new field of light sources which shows promise of many applications. It may be interesting to add a further word of description of the conducting glass referred to in the paper. This Corning E-C or Electrical Conducting Glass consists of a good insulating glass as a base with a fired-on electrically conducting coating on the surface. The coating is thin, of the order of .00002" thick and quite transparent with a transmission of about 85 per cent in the case of certain coating compositions. The coating is hard and extremely resistant to chemical attack in the absence of reducing agents. It can be applied to a variety of glass compositions to make a finished product that is economically practical as far as the cost is concerned. It may well be that we have seen today the beginning of a new era in the illuminating field.

C. L. Cottrell**: This new approach to the problem of producing "cold light" is extremely interesting. As implied in the paper, the source of the energy converted into light seems to reside in the dielectric displacement currents causing changes in the molecular or atomic energy states which on reduction produce the emission of light. In so far as the reconversion of this energy may be delayed by some of the elements involved, the modulation of light from this type of source might be reduced. This would be an obvious advantage in reducing stroboscopic effects. Have any of the materials showing these phenomena been found to have a light emission somewhat delayed beyond the changing field?

*Corning Glass Works, Corning, N. Y.

**Assistant Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

Elmer C. Payne, E. L. Mager, C. W. Jerome*: In regard to the increase of light output with increasing frequency, the explanation put forth in the paper may be re-stated: It appears that a definite quantity of light is emitted at each electrical impulse, and hence the more impulses per second, the more light emitted.

The effect of such factors as dielectric constant, resistivity, temperature, etc. upon the efficiency and light output will be discussed in a forthcoming paper.

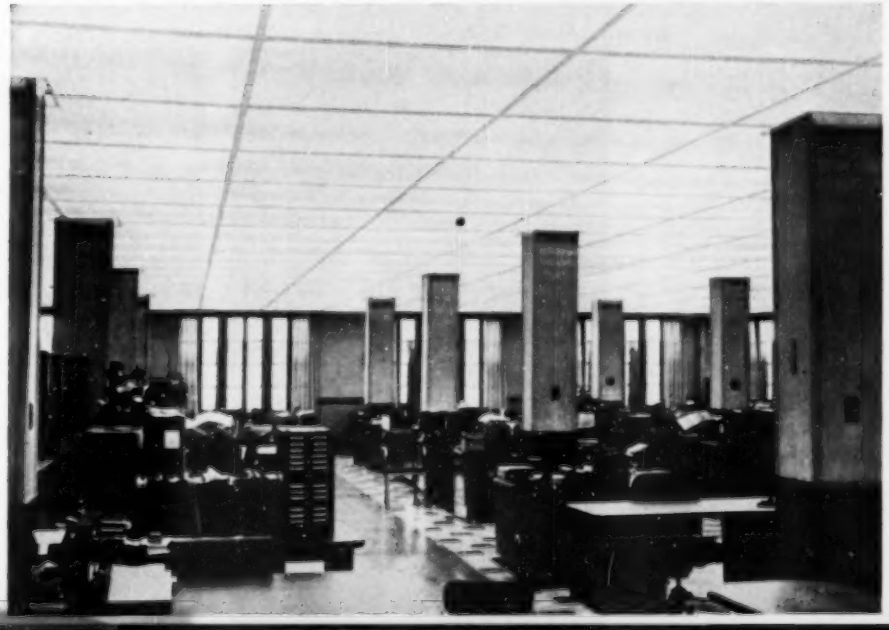
When a d-c potential is applied to a luminous capacitor, a single flash of light is emitted. When the source of potential is simply disconnected, of course nothing happens; but when the capacitor is short-circuited, or otherwise quickly discharged, another flash is emitted.

Brightness values of about 20 footlamberts were obtained at frequencies of 3500-4000 cycles per second.

In answer to Mr. Cottrell's question, we have no evidence of any delay in the light emission process. Referring to Figs. 2 and 3, the cyclic variation in light intensity shown there appears to indicate little if any lag in this process.

*Authors.

ELECTRIC SUPPLY CORPORATION installed a plastic louvered "ceiling of light" in the recent modernization of its offices at 705 W. Jackson Blvd., Chicago. Victor L. Charn, architect, used feather-weight moulded plastic ceiling grilles for pleasant, even, wall-to-wall illumination. Light source is simple fluorescent strip with reflector, mounted direct to ceiling. Grilles are installed below to provide maximum "sifting" of rays and shielding of lamps. Approximate area 6,000 sq. ft. Average intensity—50 footcandles. Photo courtesy of Leader Electric Co.



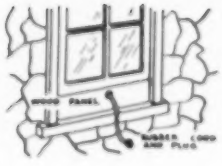
"Christmas Tricks"

The simplicity of this trick belies its effectiveness. Tissue-paper window panes have replaced the windows of an inexpensive cardboard doll house; an upright screw base socket receptacle on the "floor," with a 7½-watt lamp, lights all the windows. "Outdoor floodlighting" is from lens-end flashlight lamps, and a 2-volt toy transformer hidden in a snow bank. (Photo courtesy of Helen G. McKinlay, Cleveland, Ohio.)

Above — Cardboard "collars" held together with scotch tape conceal two Christmas tree strings to illuminate the tinsel tree in this table decoration. Lighted packages are simple wire frames, Christmas tree lamps, covered with white tissue paper. (Photo courtesy of Helen G. McKinlay, Cleveland, Ohio.)

At left — Paper angels sing before a stained-glass window in this spectacular Yuletide home display. The "Cathedral" window is made of colored Cellophane, cardboard cutout mounted on a simple wood frame, and flooded from behind by a 150-watt R-40 spot clamped to the frame. (Photo courtesy General Electric Co., Cleveland, Ohio.)

Lower left, top — A simple trick for temporary outlet for out door Christmas lighting; bottom, Projector lamp creates shadow greeting. Below, simple but effective Christmas portals. (Illustrations courtesy of Westinghouse Electric Corp., Bloomfield, N. J.)



Lighting a Small Auditorium-Ballroom

LIGHTING OBJECTIVE: To provide flexible lighting suitable for a combination auditorium-ballroom.

Installation at Seventh Floor Auditorium, Life Insurance Company of Georgia
573 West Peachtree Street NE, Atlanta, Georgia

General Information: The auditorium measures 80 x 37 feet in plan and has an 18-foot ceiling. A curtain across one end may be drawn to create a stage when the room is used as an auditorum. Surface characteristics are as follows:

Ceiling		
plaster	light green	80% RF
acoustical tile	white	76% RF
Walls		
upper	light oak	62% RF
wainscot	dark walnut	18% RF
Floor	hardwood	39% RF
Draperies	gray, green, yellow	56% RF (average)

Installation: Several different levels of illumination are provided by lighting equipment built into the ceiling.

(over)

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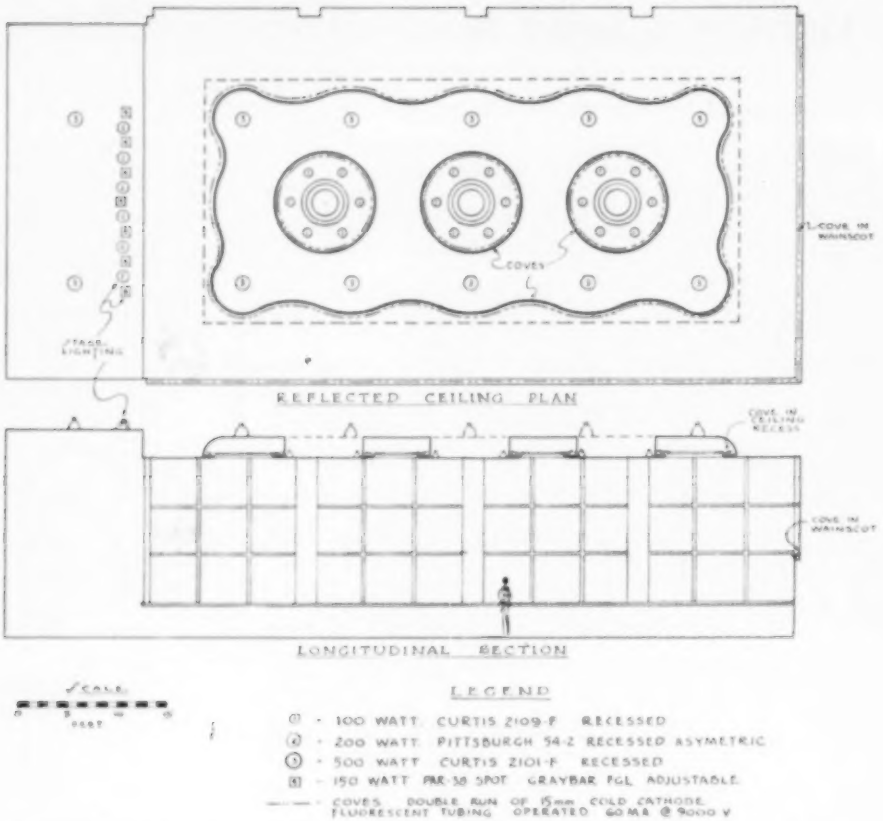

COVE IN WAINSCOT
COVES
STAGE LIGHTING
REFLECTED CEILING PLAN
COVE IN CEILING RECESS
COVE IN WAINSCOT
LONGITUDINAL SECTION
CALC.
OBST.
LEGEND
① - 100 WATT CURTIS 2109-F RECESSED
② - 200 WATT PITTSBURGH 54-2 RECESSED ASYMETRIC
③ - 500 WATT CURTIS 2101-F RECESSED
④ - 150 WATT PAR-38 SPOT GRAYBAR PGL ADJUSTABLE
—— - COVES DOUBLE RUN OF 15mm COLD CATHODE FLUORESCENT TUBING OPERATED 60 MA @ 9000 V

Edges of (1) scalloped contour of the recessed ceiling panel, (2) three round center areas, and (3) wainscot (on two sides of room only) form coves each containing a double row of 15 mm cold cathode lamps operated at 60 ma and 9000 volts as indicated in sketch. This indirect system provides 6 footcandles illumination.

Flush mounted filament lamp units (see sketch) are available to bring the illumination level up to 25 footcandles when required.

Stage lighting units are built into the ceiling to provide 115 footcandles on the stage area. Floor outlets are available for footlights when required. All stage lighting is controlled from a separate panelboard off-stage.

Resultant brightnesses with all lamps (except stage lighting) operating are indicated below:

Plastered ceilings	120 ft L	Floor	6.25
Acoustical tile ceiling	18.4	Downlights	
Upper walls	15.5	60° to vertical	4500
Wainscot	1.8	75° to vertical	2500

Architect: Bodin and Lamberson, Forsyth Bldg.; illuminating engineer: Jack H. Murrah, Georgia Power Company; electrical contractor: Bartenfeld Electric Company, 488 Plum Street NW; luminous tubing installed by Acme Neon Company, 34 Alabama Street SW—all of Atlanta, Georgia.

Lighting data submitted by Ray H. Hiller, Curtis Lighting, Inc., 231 Healey Bldg., Atlanta, Georgia, as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society
51 Madison Avenue, New York 10, N. Y.

Lighting of the Brooklyn-Battery Tunnel

By LEO GEENENS and KIRK M. REID

THE LIGHTING technique employed in the Brooklyn-Battery Tunnel, new vehicular link between Brooklyn and New York, departs radically from former practices. The objectives — and the innovations employed to achieve them — may be outlined as follows:

Objective No. 1:

A cheerful, inviting appearance of the lighted tunnel. Achieved with high efficiency by distribution of light from luminaires largely to adjacent white-tile sidewalls and ceiling, rather than directly to the pavement. High efficiency is maintained by frequent washing of the tunnel and lighting equipment.

Objective No. 2:

Pleasant and comfortable driving, without flickering shadows and highlights and the effect of successive flashes of lights in motorists' eyes. Achieved by use of fluorescent lamps, of low brightness, in two virtually continuous lines, one along each tunnel wall near the ceiling.

Objective No. 3:

Flexibility of illumination level, readily controllable to take into account the outdoor light condition, state of cleanliness of tunnel walls and ceiling, and possible future trends in lighting standards. Achieved by series-type circuits, with current in all circuits controlled from one location. Other than in the entrance sections, cold-cathode fluorescent lamps are operated at currents from 50 ma in summer up to 120 ma in winter.

Objective No. 4:

Satisfactory eye adaptation of motorists entering the tunnel on bright days. Achieved by stepped-up lighting within each entrance, employing slimline (hot cathode) fluorescent lamps. Lamps are operated at currents as high as 450 ma just inside the portals, with progressively lower currents, down to 75 ma, throughout 1800 feet.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Pasadena, California, August 21-24, 1950. Authors: Electrical Engineer, Triborough Bridge and Tunnel Authority, New York City, and Illuminating Engineer, General Electric Co., Nela Park, Cleveland, Ohio, respectively.

Objective No. 5:

Continuity of illumination. Possibility of "blackout" minimized by use of four circuits, two from Manhattan and two from Brooklyn. Groups of six luminaires — each approximately 75 linear feet in length — are staggered among the four circuits.

Objective No. 6:

Safety of maintenance crews. Achieved by minimizing traffic interruption through use of high-speed washing facilities and two-lamp assemblies designed for quick replacement. A special push-pull socket safeguards lamp-replacement personnel.

Objective No. 7:

Low cost of lighting installation. Achieved by series circuits of relatively small wire, by grounded returns on the secondaries of the insulating transformers, and by luminaires moderate in cost and not of "built-in" design requiring special construction of sidewall or ceiling.

Objective No. 8:

Low cost of lighting operation. Achieved by the high efficiency and long life of fluorescent lamps, by facilities for rapid washing and lamp replacement, and by rugged, long-life equipment construction.

The Tunnel

The tunnel runs from Battery Park, at the southern tip of Manhattan, to Hamilton Avenue in Brooklyn, as sketched in Fig. 1. It passes near the easterly shore of Governor's Island. The length is 9,117 feet. At the New York end the principal access roads are the Westside Elevated Highway and the East River Drive. At Brooklyn it connects with arteries leading to all parts of Long Island.

The tunnel was started by the New York City Tunnel Authority, later consolidated with the Triborough Bridge and Tunnel Authority. The latter Authority completed the work. Construction, begun in 1940, was stopped for three years during the war. It was opened for traffic on May 25, 1950. The cost was approximately 80 million dollars, financed originally by R.F.C. and later by a private bond issue. Toll charges range from 35 cents for passenger cars to $1.25 for the heaviest trucks.

Figure 1. The Brooklyn-Battery Tunnel, here shown in relation to its principal access roads, has averaged approximately 40,000 vehicles a day during its first summer of operation.

The tunnel comprises twin tubes, each carrying one-way traffic in two lanes. A tube cross-section is shown in Fig. 2.

Inviting Appearance

Many people think of tunnels as uninviting, or even oppressive. In some part this impression is due to the narrow confines, dictated by the very high cost of tunnel construction. Even more, it often results from dimly lighted and discolored sidewalls and ceilings. A dark ceiling, particularly, puts in effect an unattractive "lid" on the roadway.

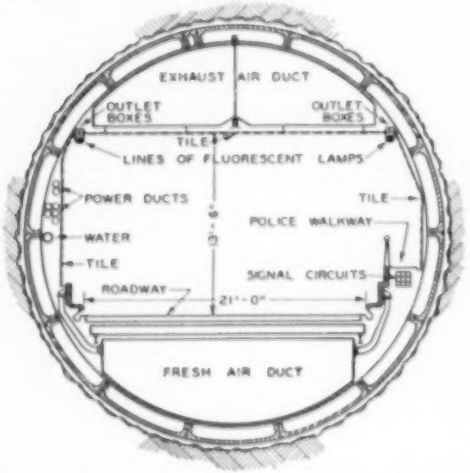


Figure 2. Tunnel cross-section shows locations of lines of fluorescent lamps.

In the Brooklyn-Battery Tunnel three things are relied upon to give the inviting appearance depicted in Fig. 3:

First — a white-tile finish on sidewalls *and ceiling*. True, this is a costly finish to install. But, unlike concrete, it does not become blackened by oily soot, with attendant need of very expensive refinishing. It cleans well. And it makes possible a design of lighting system of outstanding overall efficiency and effectiveness.

Second — a lighting system which puts light largely on the adjacent sidewalls and ceiling, as indicated in Fig. 4. These white-tile surfaces have a reflectance of over 75 per cent, as contrasted with 13 per cent for the roadway. Hence light falling on the walls and ceiling is highly effective in creating a cheerfully bright environment. Further, a substantial proportion of that light is reflected to the roadway, with relatively even distribution and a minimum of moving shadows cast by vehicles.

Third — facilities shown in Fig. 5 for thorough and rapid washing of the sidewalls and ceiling, and at the same time the lighting equipment. The washing schedule is that already in use in the Queens-Midtown Tunnel, also operated by the Triborough Bridge and Tunnel Authority. The schedule consists of washing with a 125-pound spray of soap and water, followed by a 125-pound spray of clear water, every two weeks beginning in the spring as soon as frost danger has abated and continuing until frost danger returns in the fall. In addition, there is a spray-washing with clear water once a week in spring and fall and twice a week in summer. In winter there is a spray-washing with soap and water whenever the temperature rises above frost level for several days.

Comfortable Driving

Fig. 3 shows a photograph of the tunnel interior. The brightnesses, as measured from the driver's seat of a car, range from approximately 6.0 ft-L to 0.5 ft-L, a ratio of approximately 12. These measurements were made with the lamp current 50 ma and the ambient temperature 70°. The higher values apply to the lighting equipment in the foreground, while those in the lower range are found on the roadway and in the central portion of the ceiling.

These brightnesses and ratio may be contrasted with those in the Queens-Midtown Tunnel. Here, with a representative filament lamp system the brightnesses seen by a motorist range from approximately 15.5 ft-L at the lighting equipment to 0.16 ft-L on the roadway, a ratio of approximately 100.

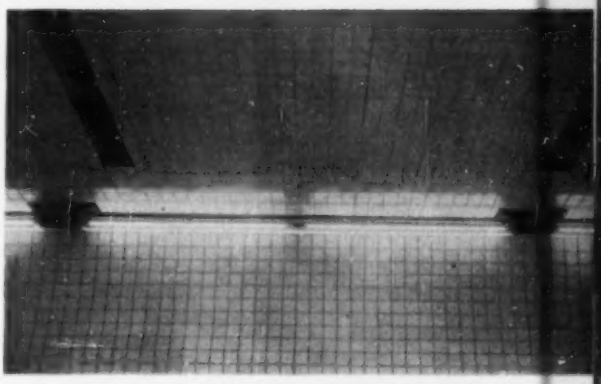
The gain in motorist comfort attributable to the moderate brightness contrasts in the Brooklyn-Battery Tunnel must be experienced in a moving car in order to be appreciated fully. Hence the authors plan to present at the National Technical Conference at Pasadena a motion picture of rides through the Brooklyn-Battery and Queens-Midtown Tunnels.

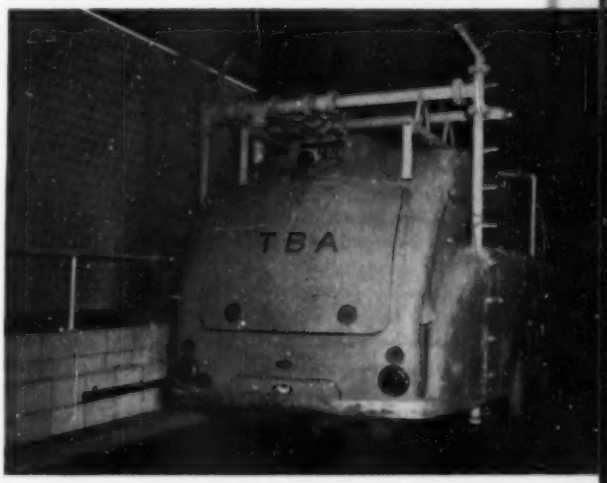
As the photograph in Fig. 3 indicates, the clear Pyrex tubes appear to be almost uniformly "filled

Figure 3 (Top). Even illumination and moderate brightness contrasts enhance the cheerful appearance of the tunnel and set a new standard of motoring comfort.

Figure 4 (Center). The lighting system comprises over 36,000 linear feet of luminaires. The luminaires emit over 90 per cent of the generated light. Over three-fourths of the emitted light falls on the white-tile sidewalls and ceiling.

Figure 5 (Bottom). Periodic washing of sidewalls and ceiling, as frequently as twice a week, keeps the tunnel fresh and inviting, and maintains high efficiency of lighting.





with light" at the angles at which a motorist sees them through the windshield. At those angles the brightness of a tube (approximately two and one-half inches outside diameter) thus becomes less than half the brightness of the T-8 lamp (one inch diameter). In fact, at those angles no significant difference in appearance was found between clear and inside-frosted tubes. Hence clear tubes were chosen because of greater strength, higher light transmission, and lower cost. The socket housings serve as baffles in increasing degree as one looks farther down the tunnel.

Flexibility of Illumination Level

Tunnels are long-time projects. During the life of a tunnel the prevailing standards of roadway illumination may be expected to increase substantially. A lighting system in which the illumination level can readily be stepped up along with advancing standards helps greatly to keep a tunnel "modern."

The lighting system in the Brooklyn-Battery Tunnel has such flexibility. The series circuits, shown schematically in Fig. 6, assure that the lamps will start in cold weather, and permit ready control of current from the tunnel switchboard. Adjustments may be made to take into account the outdoor light condition, and also the state of cleanliness of the tunnel sidewalls and ceiling and lighting equipment. Current adjustment also solves the problem of compensation for the characteristic reduction in light output of fluorescent lamps in cold weather. Four light cells, two in each tube of the tunnel, show readings on the switchboard for the guidance of the operator in adjusting the lamp current.

Fig. 7 shows how the light output of the fluorescent lamps, as used in this installation, is affected by lamp currents from 50 to 450 ma and by ambient temperatures from 0° to 80°F. The glass tube enclosing the two lamps helps to maintain the efficiency and light output of the lamps at low ambient temperatures. At high ambient tempera-

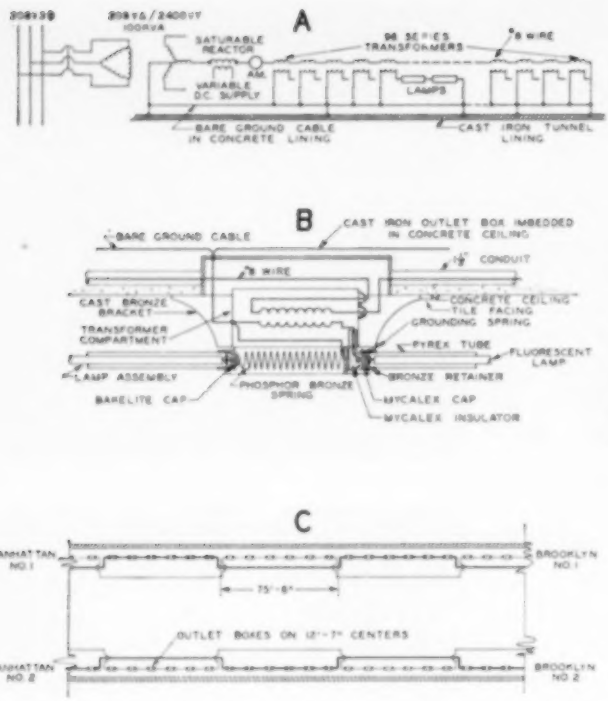


Figure 6A. Series circuits as used in the tunnel are simple and low in cost compared with multiple. They afford control of lamp current from one location by means of saturable reactors. B. Each series transformer serves one pair of lamps through the specially-designed sockets illustrated. (Courtesy of patentee.) C. Four circuits, two from Manhattan and two from Brooklyn, supply the lighting in each tube in staggered arrangement.

tures, particularly when accompanied by high currents in the "daytime" entrance lighting, the glass enclosure contributes to overheating of the lamps with accompanying reduction in efficiency and light output.

Other than in the entrance sections, cold-cathode lamps of standard warm-white color are used in the original installation. They are operated at 50 ma in warm weather, and the current may be raised to as much as 120 ma if need be to compensate for cold weather and dirt accumulation. Whenever a higher range of current values might be desired, slimline (hot cathode) lamps can be substituted with no change in equipment. Circuits and controls permit lamp currents up to 200 ma.

The special sockets, pictured in Fig. 4 and shown schematically in Fig. 6B, accommodate either cold-cathode or slimline fluorescent lamps. The housing for transformer and sockets is a single bronze casting. Bolts and screws are silicon bronze. High-voltage insulators are glazed porcelain and micalex plastic — both not-tracking, *i.e.*, any arc flashing over these surfaces does not damage them. Low-voltage insulation is bakelite plastic. Springs are phosphor bronze. All these materials are highly resistant to corrosion; instead of attempting to keep the housings water-tight, wash-water is encouraged to flow through to cleanse them. This cleaning method is feasible with the series distribution and materials employed. The transformer is encased in a compound-filled compartment of the housing. One end of the secondary is grounded;

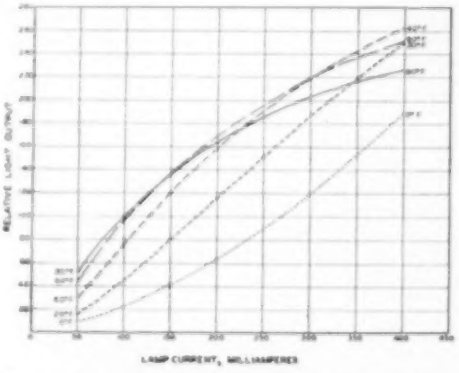


Figure 7. Light output of fluorescent lamps is markedly affected by lamp current, ambient temperature and wind, and the heat-insulating characteristics of the luminaire. Above data apply to 6-ft. T-8 fluorescent lamps, after 100-hour seasoning, in Pyrex tubing of 2-in. inside diameter, in still air.

the other is molded as part of the socket assembly, thus eliminating all secondary wiring.

The two-lamp assemblies have gasketed caps which are turned down solidly on threaded ends of the Pyrex tubing to form water-tight and air-tight joints. Long flat glass plates could not be gasketed so tightly without danger of cracking.

Each series line, as shown in Fig. 6A, is controlled and ballasted by a saturable-core reactor. The secondary current depends on the current applied to the d-c coils. These saturable reactors take the place of the constant-current transformers normally used to supply series circuits. An important design feature of the reactors in this case is that full open-circuit voltage is always delivered at the time of closing the circuit and at each half-wave. This assures starting of the fluorescent lamps, and minimizes any tendency of the lamps to flicker, regardless of the lamp current which the reactors may be set to deliver.

"Daytime" Entrance Lighting

The "daytime" entrance lighting in each tube extends 1800 feet. The lighting equipments are the same as those used in the rest of the tunnel, but the lamps are slimline instead of cold-cathode. On bright days the lamp current is 400 to 450 ma throughout the first 150 feet of tunnel, 350 to 400 ma throughout the next 300 feet, and so on, stepping gradually down to a minimum of 75 to 100 ma at the end of the 1800 feet. On dull days these higher currents are scaled down. At night the current throughout the 1800 feet is 75 to 100 ma, or up to 120 ma if needed in cold weather to match the illumination level of the rest of the tunnel.

The slimline lamps used in the entrance sections are filled to approximately double the normal argon pressure of 3.5 mm. This is done to minimize electrode disintegration and to obtain satisfactory lamp life at currents of 75 to 100 ma—abnormally low for slimline lamps. This change in filling pressure in turn requires starting voltage higher than normal. The transformers were designed accordingly.

Experience on sunny days during the early summer of 1950, with illumination up to approximately 8,000 footcandles on the roadways outside the portals, indicates that this "daytime" entrance lighting gives satisfactory eye adaptation. This result is due to several features of lighting and tunnel construction, all contributing to attainment of two objectives:

First — relatively high brightness of the overall field of view of motorists entering the tunnel. This field comprises largely the sidewalls and ceiling and roadway. As already pointed out, the white-tile sidewalls and ceiling are favorable for building brightness; the roadway is not. Hence in the entrance sections it is particularly important to have the light from the luminaires distributed largely to the sidewalls and ceiling. Experiments in another New York tunnel showed that eye adaptation became much more satisfactory with less than half the wattage when the light was directed to the sidewalls rather than to the roadway. Further, a moderate curve shortly after entering the Brooklyn-Battery Tunnel in each direction helps greatly to make the bright sidewall the dominant part of the field of view. This not only assists in eye adaptation, but also reveals cars ahead in pronounced silhouette. And, to repeat, the frequent washing schedule in summer assures a high maintained brightness of the field of view within the tunnel entrances during the time of year when outside daytime brightnesses are highest.

Second — a relatively long interval of gradual eye adaptation after the motorist gets inside the tunnel. This is the reason for extending the entrance lighting over a length of 1800 feet. After the first major transition from the brightnesses produced by sunlight to those inside the entrance, motorists' eyes are permitted to make their further adaptation slowly. In contrast, with only a short length of entrance lighting of higher level the eyes of motorists are not subjected to quite as much change when entering a tunnel, but almost immediately they are expected to make a further substantial adaptation.

Continuity of Illumination

A sudden "blackout" of the lighting in any substantial length of a tunnel is a serious hazard, and a frightening experience. Fig. 6C shows how the possibility of such a "blackout" is minimized by staggering adjacent groups of 6 luminaires among four sources of supply. Each group of 6 luminaires extends approximately 75 feet along one wall of the tunnel.

Lamp outages due to burnouts will be minimized by group replacement. In the entrance sections two group replacements a year may be found desirable. Throughout the rest of the tunnel one group replacement a year is expected to be sufficient.

Safety of Maintenance Crews

When a maintenance crew is at work in one lane of a tube, all traffic is routed along the other lane by the tunnel police. Nevertheless, the faster the washing and lamp-replacement operations, the less interruption of traffic and the less hazard to personnel and to motorists.

The washing truck, Fig. 5, carries enough water to wash the full length of one sidewall, or half the ceiling, of a tube. Its normal speed during washing is eight miles per hour, or approximately 12 minutes for one trip through a tube. In four trips a tube is washed completely. When one truck is washing with soap and water it is followed by another spraying clear rinse-water.

The two-lamp assemblies shown in Fig. 4 are put together in the service shop. The lamp-replacement truck is specially designed to carry these 12-foot assemblies. The assemblies — and the sockets — are

designed to enable the crew to remove one from service and put another in place quickly. Replacement of lamp assemblies is made with the circuits "hot." Referring to Fig. 6B, one end of the assembly is inserted in the grounded socket, where pressure is exerted against a spring until the opposite end of the assembly clears the edge of the opposite socket and can be moved forward against the "live" terminal. The assembly cap has a bronze retainer which makes contact with a grounding spring as soon as the cap is inserted in the socket housing and before the "live" terminal makes contact. This prevents leakage currents emanating from the "live" terminal from following the exterior of the assembly to an operator holding it.

If the operator should by error first insert the assembly into the "live" socket he will not make contact even though he holds his hand against the cap at the opposite end of the assembly. This safeguard is effected by locating the contact at the bottom of a narrow cavity in the bakelite cap. Similarly, with the assembly removed, the "live" terminal in the socket housing is located at the bottom of a narrow cavity in the mycalex high-voltage insulator, thus preventing accidental contact.

Low Cost of Lighting Installation

Several factors help to keep the cost of this lighting installation relatively low. For example, the wire in the series circuits is small, No. 8, and the only secondary wiring is one ground connection at each transformer. The outlet boxes are spaced 12 feet 7 inches on centers and are located in the ceiling slab near the sidewalls, where there is minimum interference with major structural elements of the tunnel. The cost per linear foot of the luminaires is low in comparison with any equivalent non-ferrous metal trough with reflector and hermetically sealed cover-frame and glass.

It is to be noted that the extra cost of any special features of tunnel construction required by a lighting system are properly chargeable against the lighting. Built-in luminaires call for departure from the simple tunnel-wall construction, at very high cost. Luminaires not located with due regard for main structural elements or headroom may introduce prohibitive indirect costs. In the Brooklyn-Battery lighting installation, all such indirect costs were held to a practical minimum.

Low Cost of Lighting Operation

The high efficiency and long life of the fluorescent lamps are important in achieving low operating cost. For equal lumen output, and at an ambient temperature of 50° and a lamp current of 100 ma, the wattage input of this luminaire with cold cathode fluorescent lamps is approximately one-seventh that of a representative filament-lamp tunnel luminaire. The method of washing the lighting equipment along with the rest of the tunnel is fast and economical. The materials employed in the sockets and housings may be expected to give very long life with a minimum of repairs. The simplicity of the circuits reduces the prospect of operating troubles and facilitates location of any defects which may develop. It should be noted that a circuit may become grounded anywhere beyond the saturable reactor without causing a short-circuit or tripping the circuit-breaker. It is self-protecting. The life of the saturable reactors, and also the 5000-volt insulation on the series-circuit wiring, should be very long.

The handling of the 12-foot lamp assemblies, using the special maintenance truck, appears from early experience to be entirely feasible. In fact, results to date are encouraging experiments with 16-foot assemblies, housing two 8-foot lamps end-to-end, for future tunnels. An unknown factor is the extent to which flapping canvas and objects projecting from trucks may cause breakage of the lamp assemblies. Such breakage is likely to be found no more serious or costly than that of glassware used in other forms of tunnel lighting.

Lighting of Approach Roadways

The approach in New York, 900 feet long, is a 10-lane divided roadway narrowing to four lanes at the tunnel entrance. In Brooklyn, where the twelve toll booths are located, the approach is a 12-lane divided roadway, 1000 feet long, narrowing to four lanes. The average initial illumination on the pavement is approximately one footcandle. Luminaires are of the reflector-refractor type, 30 feet high, employing the 400-watt E-H1 (quartz arc tube) mercury lamp operated horizontally with external magnet. Metal poles, spaced 60 to 80 feet apart along the dividing strip, mount two luminaires each on six-foot brackets. Opposite these are poles mounting single luminaires and located on the parapet walls along the outside edges of the approach roadways. These latter poles can be revolved to swing the brackets toward the marginal streets for easy cleaning and relamping.

When a motorist, driving under the mercury lighting of the approach, first sees the warm-white fluorescent lighting of the tunnel entrance the contrasts in environment, lighting technique, and color of light are striking.

Acknowledgments

The authors acknowledge their indebtedness to Chief Engineers Ole Singstad and Ralph Smillie for encouragement and cooperation during experi-

ments, designs and tests of this lighting system, to H. W. Lord for recommendations on series circuits with saturable reactors, to J. Peterson and his associates in the General Electric Lighting Division at Lynn for design of the special series transformers and reactors, to R. N. Thayer and A. B. Oday and others in the Lamp Development Laboratory and Engineering Division at Nela Park for cooperation in development of the lamps employed, and to personnel of the Triborough Bridge and Tunnel Authority who contributed to the design, testing, and installation of the lighting system.

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DISCUSSION

OLE SINGSTAD*: The paper by Mr. Geenens and Mr. Reid is very interesting and sets forth concisely the merits and characteristics of the lighting installed in the Brooklyn-Battery Tunnel, which when adopted during the planning stage of that tunnel in the early nineteen forties, was the first application of the fluorescent type of lighting in a major tunnel project. Ever since the planning of the first important vehicular tunnel, the Holland Tunnel, during the early nineteen twenties, the interior finish and lighting of this type of tunnel have been given intensive study and experimentation by the writer and his staff. It was realized at that time and it is equally true today, that vehicular tunnels should be not only safe and comfortable to the traveling public but should present an attractive appearance and be well illuminated. This consideration applies with added force because of the fact that most of these tunnels are toll projects and it is the belief of the writer that the money spent on the tiling of the tunnel walls and ceiling as well as its adequate and appropriate lighting has a commercial value which well justifies the cost. The Holland and Lincoln Tunnels were built before the fluorescent lighting for outdoor use had been developed.

At the time of the planning of the Queens Midtown Tunnel, we were seriously considering the use of fluorescent lighting and Mr. Geenens, The Tunnel Authority's Electric Engineer, carried on a great deal of experimenting with the cooperation of Mr. Reid and other engineers of the principal electrical manufacturing companies. In view of the fact, however, that the temperature in a vehicular tunnel due to the large volume of air required for adequate ventilation is practically the same as that of the outside atmosphere and in view of other considerations in connection with the development of the fluorescent light for this sort of installation it was not deemed appropriate at that time to adopt it for that tunnel even though we realized the many advantages which it offered as compared with the incandescent lighting which had been used on previous tunnels. It was, therefore, decided to use incandescent lighting for the Queens Midtown Tunnel. By the use of two lamps in each fixture, it was possible to vary the illumination of the tunnel so as to suit the outside light conditions as well as to provide a transition from the outside sunlight to the normal tunnel lighting over a considerable distance. The experiments with the adaptation of fluorescent lighting for vehicular tunnels were continued and by the time the Brooklyn-Battery Tunnel was being designed it was felt safe to specify this type of lighting for that tunnel.

The advantages of this type of lighting from the tunnel engineer's point of view are well set forth by the authors of the paper under objectives Nos. 1, 2, 3, and 8, and particularly objective 2. The characteristics described under objectives Nos. 4, 5, 6, and 7 are also present in this installation but in the writer's opinion these four characteristics can be attained with the incandescent lighting as well.

The attractiveness and efficiency of tunnel lighting is greatly enhanced by this new type as it gives the tunnel a cheerful and well lighted appearance at a minimum consumption of power. The elimination of the flicker reflected from the rear of cars as they pass the individual incandescent lights is a most important advantage. The slimline fluorescent light is encased in a transparent jacket of pyrex thus eliminating any shadows or dark streaks such as would be the case if the luminaire were encased in a metallic fixture. Whether the pyrex jacket should be transparent or frosted is a matter of taste,

*Consulting Engineer, formerly Chief Engineer of the New York City Tunnel Authority in charge of planning the construction of the Queens Midtown Tunnel and the Brooklyn-Battery Tunnel.

and there is no appreciable difference in the light output efficiency in either case.

It is the writer's opinion that this type of lighting adapted for use in vehicular tunnels is a great advance in tunnel lighting and will contribute toward the increasing popularity of such tunnels.

W. H. Kahler*: We are sure that anyone who has an opportunity to drive through this new tunnel in New York will agree that it is the finest tunnel lighting system ever installed. The engineers of the Triborough Bridge and Tunnel Authority have achieved illumination results that have always been desired but never before obtainable.

In reviewing the paper, several questions came to mind and we would like to have the authors' comments on these points. It is stated that brightnesses measured from the driver's seat of a car ranged from approximately 6 footlamberts on the lighting equipment to .5 footlamberts on the roadway. The value of 6 footlamberts seems to be extremely low since lighting equipment brightness would actually be the brightness of the bare lamp slightly reduced due to the absorption of the glass. The brightnesses of a luminaire of this type were measured in the laboratory with a Luckiesh-Taylor brightness meter with the lamp operating at 50 milliamperes. At 90 degrees from the lamp axis the measured brightness was 650 footlamberts, at 60 degrees 630 footlamberts, at 40 degrees 550 footlamberts, at 20 degrees 320 footlamberts and at 10 degrees 200 footlamberts. The brightness as seen by a driver of course varies with the viewing angle but even at 10 or 20 degrees the measured brightness is many times greater than 6 footlamberts. (10 to 20 degrees represents a viewing distance of about 50 feet.)

In describing the appearance of the luminaires in the tunnel, the authors have said that the clear Pyrex tubes appear to be almost uniformly filled with light at the angles at which a motorist sees them through the windshield. It is also stated that the brightness of a tube thus becomes less than half the brightness of the bare lamp. Eye observations do not verify this statement as we would expect because the clear glass tube has no diffusing qualities. The driver actually sees the bare lamp and the clear glass tubes seem to disappear against the luminous background of the white tile. This bare lamp brightness apparently does not cause any discomfort or distraction.

The electrical circuits for controlling this lighting system apparently have real advantages that minimize initial cost and simplify maintenance. It has always been understood that saturable core reactors inherently have a poor current wave shape. We are wondering what consideration was given to this detail in designing the reactor and luminaire ballasts, and if it was felt that this adverse wave shape would affect lamp life.

It is understood that the ballast in each luminaire is actually a current transformer and in the event of a lamp outage we would assume a very high open circuit voltage from the secondary of the transformer. Have open circuit voltage peaks actually been measured and is it expected that any trouble will be encountered due to high open circuit voltage when a lamp fails?

This tunnel lighting system is really an ingenious application of fluorescent lamps based upon both the fundamentals of illuminating and electrical engineering.

Kirk M. Reid*: Mr. Singstad comments that there is no appreciable difference in light-output efficiency whether lamps are jacketed in clear or in inside-frosted Pyrex tubes. Measurements in the laboratory showed a light output, compared with that of bare lamps, of more than 90 per cent for the tunnel unit with clear tubes. With inside-frosted tubes the light output was approximately 10 per cent lower. This difference was checked in a full-scale test section of tunnel. Even 80 per cent is, of course, well above the output of recessed types of tunnel luminaires.

Mr. Kahler questions the reported luminaire brightness of 6 ft-L. It is apparent that the paper — which simply refers to such measurements as made through the windshield from the driver's seat — is not sufficiently specific. The measurements, made with a Luckiesh-Taylor Brightness Meter, were averages of luminaire brightnesses 100 to 200 ft. ahead of the photometrist. These are considered to represent the luminaires seen through the top part of the windshield by drivers of average height sitting in normal driving position. At these and greater distances the clear-glass tubes appear to be almost uniformly filled with light. If the luminaires are viewed at wider angles — as, for example, by a driver leaning forward — the lamps in the foreground are clearly visible through the tubes, with attendant higher brightnesses.

Check measurements were made in the laboratory at a distance of 25 ft. on a Brooklyn-Battery luminaire at 80° F ambient temperature, for a lamp current of 50 ma. A tube brightness of 6 ft-L was found at an angle slightly more than 2 degrees from the tube axis. For a motorist in the right tunnel lane, this angle represents a point approximately 350 ft. ahead on the right line of luminaires and approximately 400 feet ahead on the left line. These laboratory data are in reasonable agreement with the field measurements, which were made at such distances that both the eye and the Brightness Meter would tend to integrate brightness over a width greater than that of the lamp alone.

The distorted wave shape, characteristic of saturable-core reactors, does not appear to give unsatisfactory lamp life. The open-circuit voltage of approximately 1500, on the secondaries of the current transformers, is not expected to cause any trouble when a lamp fails.

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*Author.

Lighting a Store

LIGHTING OBJECTIVE: To provide general lighting and highlight merchandise in a ladies' apparel store.

Figure 1.

Installation at Royer's Inc., 318 Fifth Avenue, McKeesport, Pennsylvania

General Information: The accessories department, foreground of Fig. 1, is 18 feet wide and 25 feet long. Fig. 2 shows a small lingerie department measuring 14½ feet by 16 feet between wall cases. Surface characteristics are as follows:

Accessories Department (foreground Fig. 1)

Ceiling	Ivory	76% RF
Walls	Salmon	51% RF
Coffers	Peach	57% RF
Floor	Gray	27% RF
Trim	Blond	34% RF

Lingerie Department (Fig. 2)

Ceiling	Ivory	76% RF
Walls	Peach	57% RF
Carpet	Rust	24% RF
Trim	Blond	34% RF

(over)

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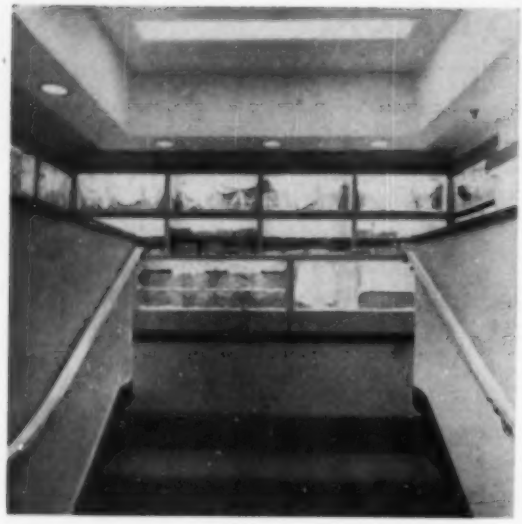


Figure 2.

Installation: General lighting is obtained in the accessories department from twelve recessed troffers (Pittsburgh Reflector Co. #PF 448 GE) covered by ribbed diffusing glass and mounted in rows of three on ten-foot centers. Each unit contains four 40-watt 3500K fluorescent lamps per 4-foot section. Accent lighting is provided by fifteen 200-watt filament lamps in recessed silver-mirrored glass concentrating reflectors equipped with concentric louvers (Pittsburgh #C101-5). A decorative touch is added by six-foot square coffers which have a double row of 20 mm cold cathode fluorescent tubing (supplied by Yost Electric Co., Greensburg, Pa.). All showcases and wall display cases have standard fluorescent lighting. General illumination in the circulation area is 60 footcandles with 100 to 133 footcandles on the showcases.

The lingerie department is illuminated by two recessed troffers and five filament lamp units identical to those used in the accessories department. Show and wall cases are illuminated with hot cathode fluorescent lamps and the wall display rack by cold cathode fluorescent tubing.

The range of brightnesses of the area shown in Fig. 1 is as follows:

floor	8-18	footlamberts
ceiling	8	"
wall (8 feet above floor)	20-22	"
troffers	500-800	"
coffers		
center	44	"
inside edge	150	"

Lighting data submitted by G. H. Maize and L. T. Kight, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania, as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society
51 Madison Avenue, New York 10, N. Y.

Air Terminal—Appropriately Modern

JUDGES for the Central New York Chapter's (I.E.S.) contest for best local installations, gave first prize to the modern installation shown here. Is is the Hancock Airport Terminal, Syracuse, N. Y., and was designed by T. S. Harmon of the Niagara Mohawk Power Co., Syracuse.

General lighting is from the suspended coves (18" below the 14' ceiling). The coves contain 72" and 96" T-8 200 ma 3500K slimline lamps single strip, used without reflectors. Reflectors were installed, but the appearance without reflectors was preferred. The bottoms of the coves have been painted yellow, of 68 per cent reflectance.

Twenty footcandles of general lighting is obtained with 300 ma 3500K white lamps using a MF of 60 per cent, but 200 ma ballasts were actually installed, with provision for an additional row of lamps, if this be desired. Actual level after six months' operation is 14 footcandles general lighting.

The ticket counter features a louvered ceiling suspended 62" above the counter, with 96" T-8 300 ma 3500K slimline lamps mounted on a furred ceiling two feet above the louvers. Illumination level after six months' operation is 37 footcandles.

The room is an "L" shape of approximately 30' x 70' and 30' x 96', with a ceiling height of 14'. The natural acoustic tile of the ceiling has a 70 per cent reflectance; walls are part green (45%), part yellow (68%); the floor is a neutral tan (50%). Top of the ticket counter is light blue, of 45 per cent reflectance.

Architect for the job was George H. Ketcham of Syracuse; electrical contractor was Fred Edinger, also of Syracuse.

Lighting for Decorative Accent

Figure 62.

General Information: Delightfully harmonious in this provincial setting is the self-illuminated picture, a recent and popular innovation. The picture is hand-painted or etched on glass and both edge-lighted and back-lighted by tubular filament bulbs concealed behind the top and bottom of the frame. Many styles are available and many novel uses apparent.

The ways in which light may be used purely for decorative accent are diverse and endless, limited mainly by the ingenuity of the designer or by costs. The purpose is solely to attain artistry in lighting effect or to enhance the beauty in form, color, texture, and line of structural elements, and of sculpture, paintings, and other art objects. Emphasis, sparkle, shadow, subtlety, or drama are the qualities sought in decorative lighting. In this realm lighting is an art, not a science. The lighting designer must grasp and maintain in the lighting, especially of sculpture and pictures, the intent and concept of the original artist.

The choice between incandescent and fluorescent light sources is largely determined by the results sought and the objects or areas to be illuminated. When accurate light control, brilliant sparkle, or extremes in highlight and dense shadow are desired, the incandescent bulb is the appropriate one. When large areas, luminous shadows, daytime color qualities, or soft diffused light are required, the fluorescent tube is more adaptable. In every case, complete shielding of the light source is essential, so that one sees the object but not the source. When the housing of the light source is visible, attention must be given to its correct period detail, form, finish, and scale.

A number of "pin-point" spotlights for picture lighting are available, to be built into side wall or ceiling, which allow complete control of the size and direction of the light beam to cover the picture exactly. Their placement requires great care to prevent reflections which might obliterate the picture, or to avoid the possibility of persons intercepting the beam as they move about the room. If a painting is to be lighted from below, there are portable decorative boxes in Contemporary and Traditional designs for placement on a mantel or chest beneath the picture. The opening may be equipped with louvers to avoid overlighting the picture and to restrict the spread of light. Flat moldings instead of deep frames are often necessary to avoid shadows. The conventional over-picture unit that attaches to the back of the frame or to the wall must be set high enough so that the upper portion of the frame is not obscured and out far enough to illuminate the entire surface of the canvas. The picture may have to be framed *without* glass to avoid reflections or unwanted images.

Lighting adds interest, color, beauty, and emphasis when used in cabinets and built-in shelves to accent hobby collections, art objects, or finely-bound books. If the shelves are of wood, the light must be incorporated vertically at the front corners or concealed behind an apron at the lower front edge of each shelf. With glass shelves, lighting can be concealed at the sides or recessed above, or below, or both.

In the lighting of sculpture, the effect desired — distance, third dimension, perspective, silhouette, shadow, contour, sharpness — dictates the number and placement of light sources and the equipment to be used.

A fireplace is most often the focal point of interest in the architectural and decorative treatment of a room. Light may be incorporated in appropriate ways to retain or accent its individuality.

The examples that follow by no means encompass all the possibilities either of application or method of decorative lighting. Nor would all the examples be equally pleasing to all tastes. They do include ideas and methods in wide range of effect as well as cost, and may suggest an expanded creativeness in the art.

Part III of the Technical Committee Report "Contemporary Lighting in Modern and Traditional Interiors" concludes the series to be published in ILLUMINATING ENGINEERING. Part I, September 1950, covered Cove Lighting, Recessed Lighting and Window Lighting; Part II, October 1950, included Wall Lighting, Ceiling Fixtures and Wall Brackets, and Lamps.

General Information: In this dining room (Fig. 63) which reveals the architectural and decorative charm of a Traditional interior, contemporary concepts of lighting are subtly employed. A pin-hole spot recessed in the ceiling accents the ancestral oil painting and another emphasizes the table appointments. A decorative wood molding applied to the ceiling conceals a strip of miniature lamps on two sides of the room. This creates a subtle glow and a brightness variation in the wall treatment.

Figure 63.

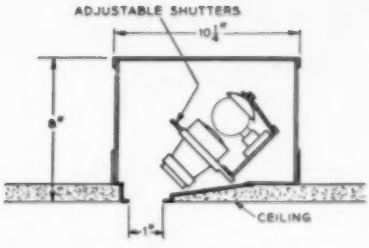


Figure 64. Section through recessed spotlight using a 100-watt G-16⅔ bulb, replaced from floor above. Adjustable baffles provide exact focusing of the light beam to fit the portrait. The ceiling opening is 18 inches from the side wall.

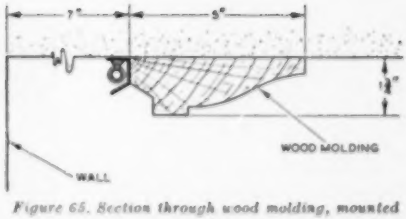


Figure 65. Section through wood molding, mounted on ceiling to conceal a 16-foot strip of miniature 6-volt, T-3¼ bulbs placed on 3-inch centers.

Figure 66.

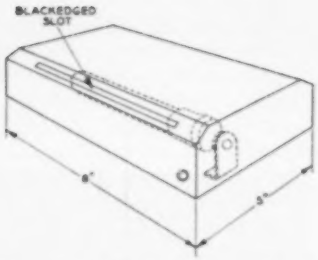


Figure 67. Perspective view through decorative brass box which contains a T-6½ 25-watt clear bulb (intermediate socket).

General Information: The method of lighting this oil portrait (Fig. 66) succeeded in attaining a low illumination for subtle sharpening of contrasts which were otherwise lost in both the day and evening lighting of the walnut-panelled library. The dominance of the portrait in the mantle treatment is maintained by its lighting. A small tubular bulb is wired into an antique brass box. A narrow slot is cut in the side of its curved top to emit a small amount of light. Other appropriate objects could be similarly employed.

General Information: Accent on the wall treatment—bamboo-framed Chinese prints mounted on fabric-covered boards—is interestingly attained by recessing a continuous row of fluorescent tubes beneath glass in the free-standing backboard for the corner sectional davenport. (See Fig. 68.) Reading light at the end sections is supplied by floor lamps of harmonious design.

Figure 68. →

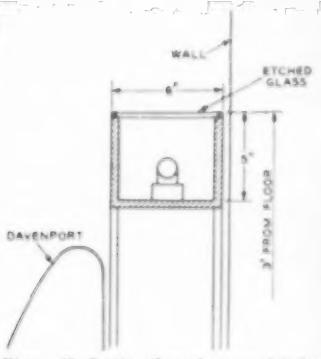


Figure 69. Section through recessed light box on top of free-standing cabinet which backs the corner sectional davenport. Ballasts for T-8, 30 watt tubes are in the channel.

General Information: Accent lighting and irregular brightness patterns were the results sought by the designer of the lighting in this Contemporary living room (Fig. 70). Three of the four pin-hole spots used to create these effects are visible, and the fourth unit highlights the cocktail table. In each of the recessed units, the aperture in the bottom plate and the lighting device within the box have been positioned to direct the light to the selected objects—the cocktail table, the painting, and the books. To produce the exact shape of light pattern desired, each unit is equipped with movable shutters. On the oil painting, for example, the shutters are adjusted so that only the canvas is illuminated, without spill-light on the gold frame.

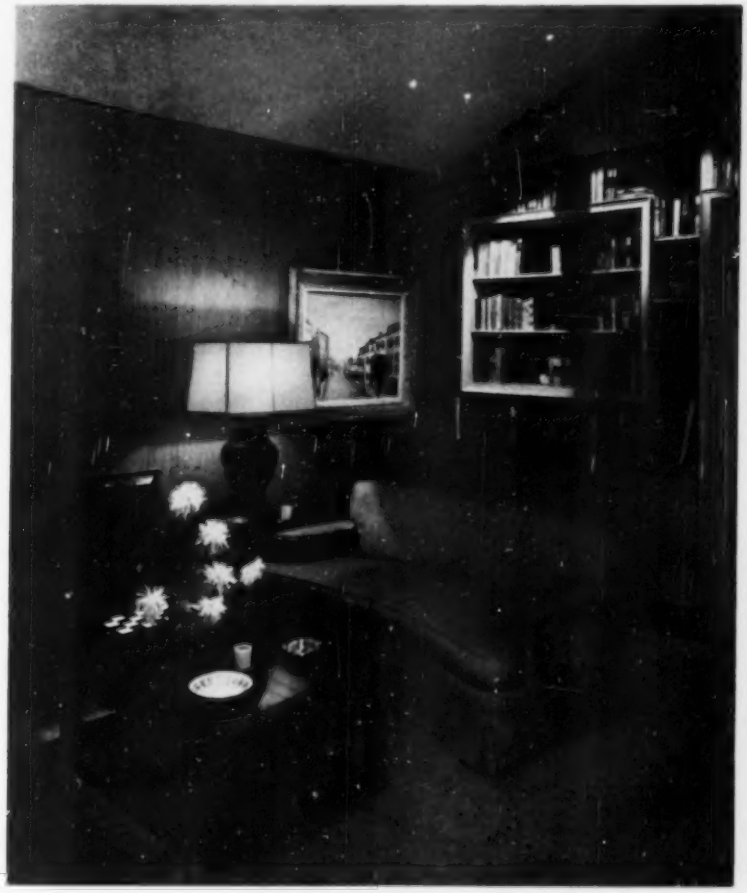


Figure 70.

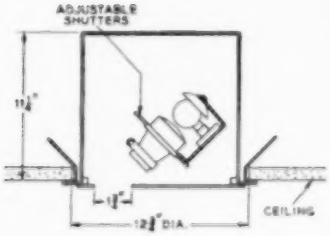


Figure 71. Section through large recessed spotlight, utilizing the G-30, 250-watt bulb. Bottom plate is removable for relamping.

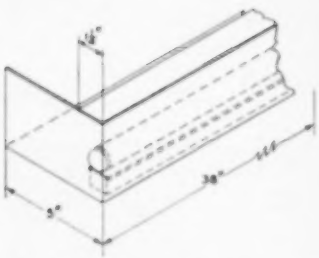


Figure 72. Perspective view of light box containing two T-8, 30-watt white luminlines.

Figure 73. →

General Information: Without some individual lighting, this narrow wall treatment (Fig. 73) would have lost prominence in the decorative flow of the rest of the room. From the home workshop came the light box, which was carefully finished to "belong" to the antique chest on which it rests. ↑

Figure 74.

← **General Information**: The colorful beauty and fine detail of this collection of Staffordshire and Chelsea figures (Fig. 74) are dramatized by light sources concealed in the space above each wall niche. This combination of art objects, light, shadow and color creates an unusual wall treatment.

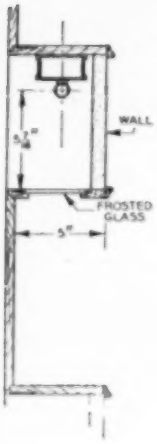
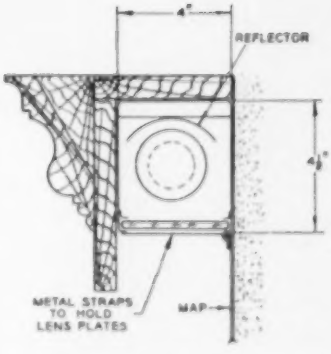


Figure 75. Section through niche wall showing the mounting above niche of T-5, 6-watt fluorescent tube. Ballast in channel.

General Information: The wall between the bookshelves in this library (Fig. 76) is covered by a mural showing the acreage pattern and scenes from the owner's rural estate. Concealed lighting brings to life the colors in the mural, making it a dominant feature of the decorative treatment, as well as contributing light at the davenport and to the general level of room illumination. The oil painting of a western scene is lighted by a conventional portrait reflector properly positioned to illuminate the entire canvas without obscuring the upper portion of the frame.

Figure 76.

Figure 77. Section through light box, which is inset behind cornice. Seams between the 4-inch by 6½-inch lens plates are covered by ½-inch by 4-inch metal straps. Twelve 40-watt bulbs are on approximate 6½-inch centers.



General Information: The request to build light into the collector's cabinet, shown in Fig. 79, presented difficulty in concealing the lamps because of both the narrow mahogany framework and the back mirror. Complete light-coverage of the Royal Doulton figures (carefully spaced on the glass shelves to avoid casting shadows over each other) was attained by inserting the smallest diameter fluorescent tubes into a lengthwise slot cut in the top center of the cabinet. Two six-watt nine-inch tubes were preferred to one 15-watt 18-inch tube because of both tube diameter and lower light output.

Figure 79.

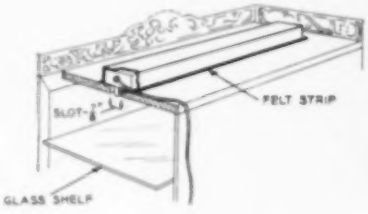


Figure 78. Perspective plan of wood-encased wiring channel placed above a seven-eighths-inch slot in cabinet top. T-8, 6-watt fluorescent tubes are used with the ballasts in the channel.

General Information: The 18th and 19th Century art treasures displayed in this antique secretary (Fig. 80) are seen with museum emphasis by the use of a 36-inch fluorescent tube concealed at the top inside front edge. Glass shelves replace the original wooden ones and the interior is painted ivory, although it might be covered in appropriate fabric or painted a darker color if greater contrast between the objects and background were desired.

Figure 80.

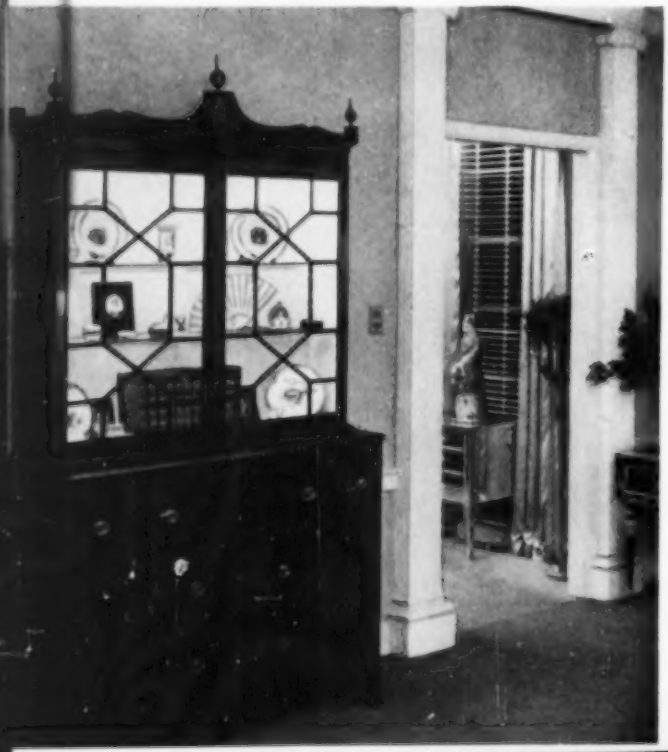


Figure 81. Section through shelves of secretary in which a T-8, 30-watt fluorescent tube is concealed.

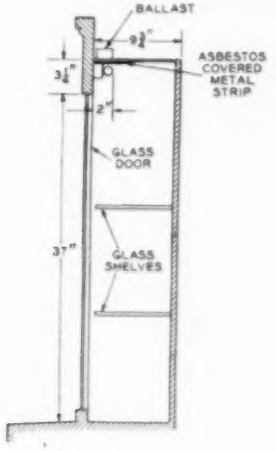


Figure 82.

←

General Information: Second only to the convenience of being able to read book titles is the colorful charm that lighted bindings can add to a room's decorative scheme. (See Fig. 82.) Here two small fluorescent tubes are mounted end-to-end behind the overhanging lip at the front of each shelf.

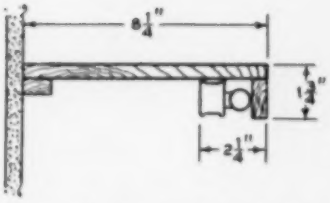


Figure 83. Cross section of one shelf in recessed bookcase, ballasts in separate box. Two T-5 fluorescent tubes, one 8-watt and one 15-watt, are placed end to end in each shelf.

Figure 84.

General Information: Interesting variations in light value and shadow are created in this three-section wall cabinet (Fig. 84) by the clever placement of two fluorescent tubes. One tube, mounted over an opening cut in the top of the cabinet, illuminates the recess below and at the same time provides some indirect lighting; the second tube, installed at the top front of the bottom section, produces contrast in brightness and sends light upward to the middle section through an aperture. →

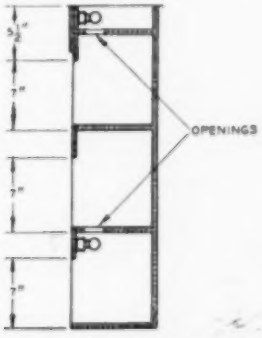


Figure 85. Section through wall cabinet; ballasts for the two T-8, 30-watt fluorescent tubes are located in separate box.

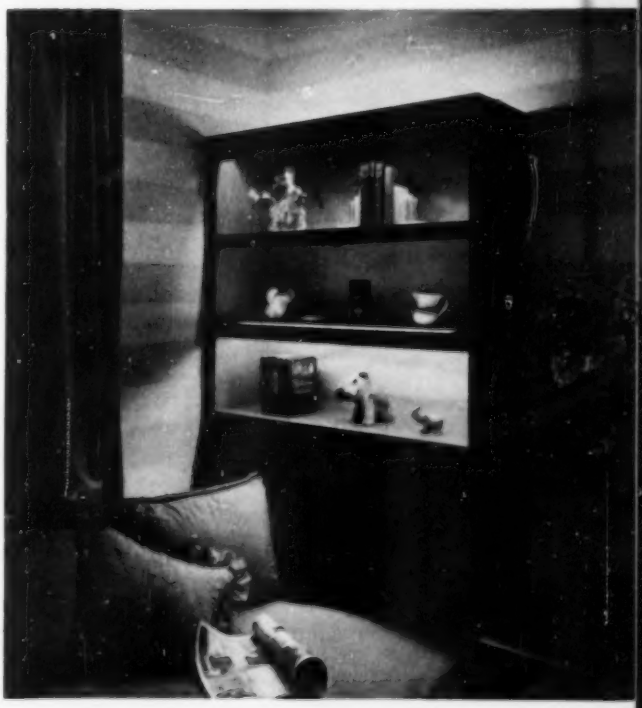


Figure 86.

←

General Information: Natural and interesting shadows are produced by a strong directional beam of light from a custom-built pin-hole spot recessed in the ceiling as shown in Fig. 86. Against the comparatively low level of surrounding illumination, the white statue stands out boldly before the dull gold background, and the skillful adjustment of baffles or shutters confines the accenting light to the figure.

→

General Information: Light on this unique specimen of driftwood (Fig. 87) emphasizes its texture and shape as it creates outlines both pleasant and grotesque in the shadows and highlights. The mirror on the walls of the fireplace recess reflects the driftwood, revealing its twisted "arms" in many variations. A lens plate is located three-quarter inches above each ceiling aperture. To reduce brightness to a minimum the risers of the lens are painted black. The fascination that shadow, brilliance, and reflection give to the ornament would be lacking without the use of light and mirror.

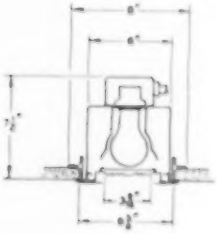


Figure 88. Section through ceiling recessed downlight. A standard 75 watt inside frosted bulb is used.

Figure 87.

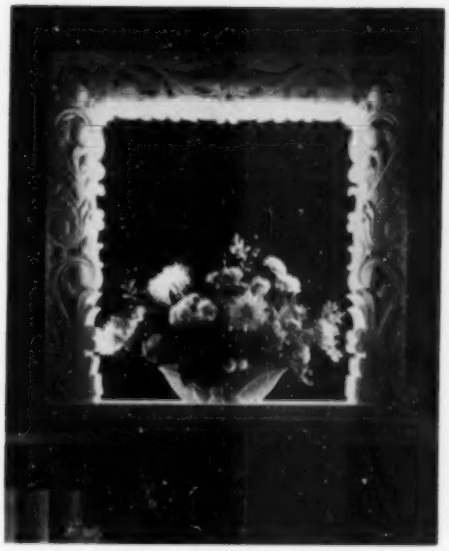


Figure 89.

←

General Information: Drama of light, shade, and color is created in this unusual handling of a mantel mirror (Fig. 89). Light is the vibrant element in giving definition to the sculptured plaster frame, in maintaining the outdoor colorfulness of the flowers, and in creating an illusion of depth and space.

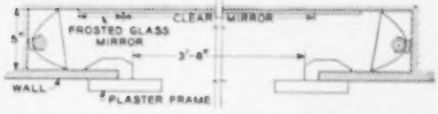


Figure 90. Horizontal section through over mantel frame and recessed mirror. T-6, 42-inch fluorescent tubes are used in specular metal parabolic reflectors; ballasts in separate box.

General Information: A new mantel, formed to match the window valances, replaces a heavy oak one and conceals a 40-watt fluorescent tube (see Fig. 91). Light filters through a ribbed frosted glass inset to put realism into the painted delphinium. Some reflected downward light brings out the color and form of the field stone.

Figure 91.

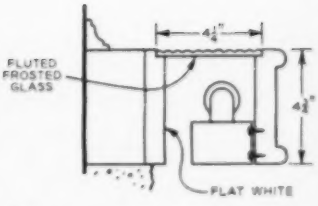


Figure 92. Section through mantel, showing side mounting of channel containing ballast for T-12, 40-watt tube.

Figure 93.

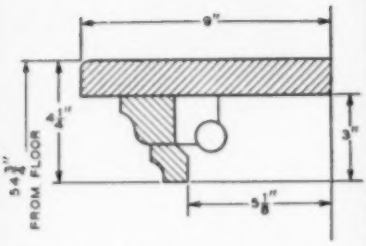


Figure 94. Section through mantel; three T-8, 30-watt straw-colored lumilines.

General Information: In the Early American room with its pine-panelled fireplace shown in Fig. 93, it was possible to conceal a strip of straw-colored lumilines in the hollow space under the mantel. During the warm seasons the fireplace is banked with foliage, and the lighting adds emphasis to the arrangement as well as a mellow glow on the pine wall of the chimney breast. The pediment of the breakfront is given added silhouette emphasis by low lighting on the back wall from an 18-inch gold fluorescent tube.

Figure 95.

→

General Information: Vertical panels of light give luminous emphasis and definition to the flower arrangement and the architect's handling of the mirror-faced fireplace (see Fig. 95). Lumilines were used although the color quality of fluorescent tubes would be advantageous in this setting.

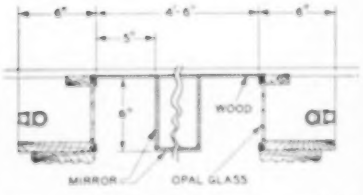


Figure 96. Horizontal section of mirrored fireplace. T-8, 40 watt inside frosted lumilines are recessed vertically at each side.

The Use of Fluorescent Tubes

Many of the rooms shown in this publication are lighted with fluorescent tubes; others combine fluorescent tubes with incandescent-filament bulbs. A considerable number use only the latter. It is now practical to work successfully with either of these light sources alone or a combination of both.

The light from filament bulbs, the only home electric source during a period of well over fifty years, has always depressed the cool colors such as the blues and greens, while the warm colors (the oranges, reds, and browns, etc.) have been enhanced.

Generally, the full values of the warm colors are acceptable when lighted with filament bulbs and when the over-all atmosphere of a room is on the warm side. This warmth, even though it is not very noticeable, plays a part in establishing friendly and home-like qualities. While many of the blues and greens in fabrics, carpets, wall paper, and paint have been dulled and changed in color, there has not been general consciousness of these shifts.

The first fluorescent tubes produced cooler atmospheres throughout rooms. Contrary to experience with filament bulbs, the blues, greens, and certain yellows were stepped up, and the warmth of the oranges, reds, browns, and red purples was depressed. Effects were obtained that had never been seen before. The fresher, clearer and cooler effects were now attainable, hence the palette of the lighting designer was extended. The fluorescent tube was a new light-source and much had to be learned about its possibilities, especially in those interiors in which the atmosphere of the room was important and in which the color rendition of materials and people was also important.

At first it was believed that fluorescent tubes served best in the kitchen and the laundry. Later, when particular attention was directed to the color chosen for a room, it became evident that the skilled designer could work successfully with the fluorescent tube in every room in the home.

Since the advent of fluorescent lighting a number of types of fluorescent tubes have been developed, including those providing about the same warmth of light as that provided by filament bulbs. Other types of fluorescent tubes have supplied the cooler whites, including those approximating daylight. Each possesses certain distinguishing characteristics. The problem of making the most advantageous selection from these various types became more complex because of the many styles and functions encountered in interior design.

The most recent fluorescent tube developments greatly simplify the choice of tube. If the over-all atmosphere of warmth associated with filament bulbs is the objective for the entire room there now is a warm quality white fluorescent tube which makes all of the colored objects and surfaces in a room appear much the same as they would under incandescent light.

If an atmosphere more nearly resembling a daylight (not the coldest blue daylight) is desired and a color rendition more nearly related to daylight is sought, a cool quality white fluorescent tube would be used.

It may be noted that these two qualities of white light from fluorescent tubes make possible either a general atmosphere of warmth as obtained from the incandescent bulb or complete departure from this warmth to a whiter over-all atmosphere. The latter creates a newer, cooler, and often fresher atmosphere. In over-all color rendition the cool quality white fluorescent tube may be expected to be the better of the two.

The most recent developments also include greatly improved-color-rendition warm and cool quality white fluorescent tubes. Each of these brings out *all* of the colors in all materials, as well as foods and complexions. With these improved-color-rendition tubes the fuller beauty of the reds, oranges, browns and purples may be seen as well as the yellows, blues and greens.

The choice of fluorescent tube now becomes simply a matter of deciding first whether a warm or a cool atmosphere is desired for any room. When color rendition is important, the corresponding improved-color-rendition warm or cool lamp would be chosen. Otherwise, the regular warm or cool white tube would serve. At this time it should be noted that improved-color-rendition is obtained at some sacrifice in the efficiency of the light production.

The market provides ceiling-fixtures, wall-brackets, and portable lamps which incorporate some of the various sizes of fluorescent tubes. No special wiring of the house is needed for these equipments since the permanently installed fixtures can be connected directly to the wires at the fixture location. Fluorescent floor and table lamps can be plugged directly into the regular convenience-outlets. The electric service should, however, be alternating current since nearly all fluorescent tube lighting devices have associated parts built into the fixtures which can operate only on alternating current.

In selecting fluorescent lighting equipment, the advice of experienced dealers or lighting designers should be sought. If devices are selected that do not supply the light needed for the given location the condition cannot be remedied since higher wattage tubes that give more light are longer and cannot be used to replace tubes that are inadequate.

When the lighting installation is built into the house or applied to the walls or woodwork, as is the case in a number of the installations shown, such as Figs. 3, 14, 39, 46, etc., reference is made to locating the ballasts in some other part of the house, such as the attic space above, the basement below, or some nearby closet. Ballasts are necessary auxiliary equipment for the operation of fluorescent tubes. The controlling current passing through the ballast may in some instances produce a low hum. When the room or the neighborhood noise level is low, this hum may become a disturbing factor, even though it is quite low. Where the installation employs a number of ballasts in any one room and the house is in a quiet neighborhood, remotely located but accessible ballasts provide complete freedom from this form of disturbance.

Since the complete listing of all sizes and colors of fluorescent tubes is

too extensive for inclusion in this publication (this information is obtainable from the manufacturers of fluorescent tubes), a few general statements appear to be in order.

Some of the fluorescent tubes that are now widely in use require a starting switch in addition to the wall switch normally used to turn the light on or off. The *automatic switch* is replaceable and is inserted into the fixture. In certain wall fixtures that can be reached and in most portable lamps a switch on the lighting device which is operated by hand (a *manual switch*) serves in place of the automatic switch. A short delay in lamp starting may be experienced with each type of starter —either the automatic or manual type.

In addition to the so-called general-service fluorescent tubes there is also another group of fluorescent tubes which range in length up to eight feet. These lamps do not require the automatic starting switch, and while the ballasts that go with them are larger, the tubes start instantly. The wire used in the metal channels and the wire used in the conduit or channel connecting the remotely located ballast with the lamp may generate vibration noises. This is overcome when the wire used has an outer layer or coating of approved material which is reasonably soft.

Fluorescent tubes can produce interference (noise) in radio reception from certain AM stations, although FM and television reception are not affected. Certain rules covering the installation, which include the use of radio-interference filters, can eliminate or minimize this difficulty. Manufacturers' literature on this subject is available.

THE RESIDENCE Lighting Committee of the Illuminating Engineering Society has over a period of 20 years studied and reported on various applications of residential lighting. The "Recommended Practice of Home Lighting" was published in 1945, revised in 1947, and its third revision is now being prepared. Within the past four years, technical detailed studies of lighting and seeing conditions for various tasks and locations in the home have been made by individual members of the Residence Lighting Committee. These studies have produced the necessary scientific background for future home lighting recommendations.

About five years ago the Society realized the lack of any I.E.S. publication on the use of modern illuminants in interiors of Contemporary and Period design. It was proposed that an illustrated brochure should be prepared and written in layman's language to increase its acceptance among home lighting specialists, architects, interior designers, educators, and those in allied fields. In 1946, the Residence Lighting Committee was given the following assignment: "To study the application of light and lighting to the home, including the study of the aesthetic phase of residential lighting, to prepare some practical reference for good lighting practices in period interiors and to report thereon."

In February 1947, the I.E.S. Council approved an outline of the contents of such a study, and in June 1950 approved the report entitled "Contemporary Lighting in Modern and Traditional Interiors" prepared by the:

SUB-COMMITTEE ON CONTEMPORARY LIGHTING IN MODERN AND TRADITIONAL INTERIORS

Myrtle Fahsbender, *Chairman*

Gladys Miller — Mary Webber — Jan Reynolds

RESIDENCE LIGHTING COMMITTEE

E. W. Commery, *Chairman*

Mary Webber, *Vice-Chairman*

Mary Dodds	J. J. Jasin	Gladys Miller
Myrtle Fahsbender	Thomas Kelly	Priscilla Presbrey
Katherine T. Goodall	W. F. Little	Jan Reynolds
Mary W. Held		Norman Vacha

Parts I, II and III of the report have been published in three consecutive issues of ILLUMINATING ENGINEERING, beginning with September 1950; Part IV will be added to the report when it is published in booklet form to be available about January 1st. Component parts of the report are as follows:

Part I (Published in the September 1950 issue)
- Lighting — Its Role in Contemporary Home Decoration
- Cove Lighting
- Recessed Lighting
- Window Lighting

Part II (Published in the October 1950 issue)
- Wall Lighting
- Lighting from Ceiling Fixtures and Wall Brackets
- Lighting from Portable Lamps

Part III (Published in this issue)
- Lighting for Decorative Accent
- The Use of Fluorescent Tubes

Part IV (To be published only in the complete reprint)
- Guide to Interior Design Characteristics and Motifs
- Glossary of Terms
- Acknowledgments

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Summary of Action Taken By I.E.S. Council Meeting, N. Y.

Councils first meeting of the new fiscal year was held in New York City, October 12, at the Lexington Hotel. Immediately preceding the Council meeting, the Society's Annual Meeting was also held, as required by the Constitution, formally presenting the Past-President's Report, and the General Secretary's Report as part of the Proceedings for the year ending September 30, 1950, and formally approving actions taken during the past year.

A large attendance was recorded at the Council meeting, including a number of visiting committee chairmen. For the record, those present were: Presiding, Walter Sturrock, President; C. H. Goddard and Lee E. Tayler, Past-Presidents; S. G. Hibben and E. M. Strong, Vice-Presidents; A. H. Manwaring, General Secretary; R. F. Hartenstein, Treasurer; R. L. Biesele, Jr., Myrtle Fahsbender, L. A. Hobbs, Duncan M. Jones, R. M. Zabel proxy for H. P. Steele, Directors; R. W. Corwin proxy for C. C. Martin, G. F. Dean, C. N. Laupp, J. S. Schuchert, R. G. Sinner, R. W. Staud proxy for K. E. Hollingsworth, G. J. Taylor proxy for J. B. Browder and F. C. Winkler, Regional Vice-Presidents; A. D. Hinckley, Executive Secretary, C. L. Crouch, Technical Director, C. E. Ellis, Advertising and Promotion Manager; A. H. Clarke, E. C. Huerkamp, B. J. Jensen, R. F. Mitchell, Harris Reinhardt and R. J. Swackhamer.

Membership Elections

One of the first reports considered by the new Council was that presented by the General Board of Examiners who reported elections to Associate and Student Members, and made recommendations for Council's action on full Member elections. The list of new members elected is included in the Telecast Section of this issue. Together with other changes, membership statistics are as shown in the preceding tabulation.

September 30, 1950		October 12, 1950
7057	Total Membership	7177
32	Members Emeritus	33*
41	Fellows	40
1610	Members	1626
5005	Associate Members	5093
369	Student Members	385

*Includes 9 Fellows of the Society.

Committee Appointments

President Sturrock presented to Council a statement of 1950-1951 Committees, together with personnel for Council's approval, calling attention to a number of new committees. Notable among the new studies to be undertaken by new committees were: Committee on Mine Lighting; a Task Committee for Advance Planning; Lighting in (Commercial) Kitchens, Lunchrooms, Cafeterias and Dining Areas; Sign Lighting; Executive Lighting Studies (Aviation); Cleaning and Dyeing Industry; Rubber Industry; Woodworking Industry.

Full text of all Committees approved, together with their personnel, is included in this issue of ILLUMINATING ENGINEERING.

Staff Pension Plan

Included in a full report of the Finance Committee was formal proposal, together with details of operation, of a retirement plan for I.E.S. staff employees. The plan proposed was based on re-study of proposals originally recommended by the 1947 Task Committee on this subject, of which A. F. Wakefield was Chairman. Discussion of the plan culminated in a resolution authorizing the adoption of the retirement plan effective October 1, 1950. Trustees appointed are: Lee E. Tayler, C. H. Goddard, Past-Presidents, M. N. Waterman, Chairman of the Finance Committee, and R. F. Hartenstein, Treasurer, with Mr. Tayler as Chairman.

Membership Directory

As part of his complete report on Publications Committee activities, E. C. Huerkamp, Chairman, reported to Council with regard to the possible publication of an I.E.S. membership roster, noting methods by which this could be accomplished, and costs. Following discussion, the Publication Committee was authorized to proceed with the publication of 1000 copies of a membership directory for sale at a price of $2.00 each.

Sustaining Members

Presentation was made by George J. Taylor of six new Sustaining Members, on which Council took favorable action, as follows:

Florida Power & Light Company
Box 3100
Miami 30, Florida
Official Representative: C. B. Vick

Fluorescent Fixtures of California
3320 18th Street
San Francisco 10, Calif.
Official Representative: Ernst O. Anders

Hub Electric Company
2219 W. Grand Avenue
Chicago 12, Illinois
Official Representative: I. M. Fixman

Iowa Electric Light & Power Co.
Box 351
Cedar Rapids, Iowa
Official Representative: Sutherland Dows

Northern Light Company
2051 N. 19th Street
Milwaukee, Wisconsin
Official Representative: Fred Cramer

Tri-Part Mfg. Company
934 Plum Street
Detroit 1, Michigan
Official Representative: Julius Resnik

In further connection with the Sustaining Membership activity, a comprehensive program for 1950-1951 was presented, prepared by C. C. Shotwell, 1950-51 Chairman of the Committee.

Membership Committee

A report on the 1950-51 program of the Membership Committee, presented by James H. Hull, Chairman, included details of the National Membership Campaign for 1950-1951. Quotas proposed for Sections and Chapters were set on a basis of 20 per cent net increases for Sections and Chapters less than three years old, and 12½ per cent net increases for those three years and over. Present Student Members would be deducted for calculation of quotas. Prizes to be awarded to the top Sections and Chapters were:

	Total New Members	Member Grade Only
First Prize	$50.00	$50.00
Second Prize	40.00	40.00
Third Prize	22.50	22.50
	$112.50	$112.50

Mexico Chapter Approved

A petition was submitted through S. G. Hibben, Chairman of the Local Activities Committee, requesting the establishment of an I.E.S. chapter in Mexico

City. He noted that Associate and Full Member requirements were in effect in the Mexican group, and indicated that all other requirements had been met including an active program of meetings in Mexico. Council voted to approve the Charter for the Mexico Chapter, with headquarters in Mexico City.

Milwaukee Now a Section

Petition was made, through C. N. Laupp, Regional Vice-President for transfer to Section status of the Milwaukee Chapter. Action was taken to approve a Section Charter to this group.

Technical Conference Plans

R. F. Hartenstein, Chairman of the National Technical Conference Committee reported that the 1950 Conference held at Pasadena in the Huntington Hotel, August 21-24, was one of the best Conferences the Society has ever had. He expressed appreciation for the fine cooperation of the hotel, the Papers Committee, Hoyt P. Steele, Chairman and the Executive Committee under the Chairmanship of D. W. Prideaux. Mr. Hartenstein reported on the Conference Income resulting from the registration of 328 members and 230 guests and expressed the belief that the Conference would show a surplus.

Mr. Hartenstein further reported that plans for the 1951 Conference in Washington, D. C. were now well organized under the local Chairmanship of G. W. Clark. He indicated that the present schedule contemplates opening the conference Monday morning, August 28, concluding with the Conference Banquet on Thursday evening, August 31.

For the 1952 Conference in Chicago, the appointment of Conference Executive Committee Chairman was confirmed, Ralph G. Raymond, General Sales Manager of the Commonwealth Edison Co., to serve in this capacity.

Action was taken, in connection with the 1953 Conference in New York City, to confirm the Conference dates as the week of September 14, 1953.

Technical Committee Reports Approved

A number of technical committee reports, submitted by C. L. Crouch, Technical Director, were approved for letter ballot, including Report No. 5 of the Committee on Standards of Quality and Quantity for Interior Illumination; Nomenclature revisions; Sports and Recreational Areas.

Mr. Crouch, in his further report on the technical activities of the Society, indicated that further technical studies in a number of fields were now nearing completion, for presentation during the coming year, including a number of technical committee reports, and several studies being made in connection with the Research Fund work.

He noted also, that during the past six years, I.E.S. has published 29 reports, now being used as valuable tools by the lighting industry — a record not to be equaled in any other Society, large or small. Five hundred technical committee members have worked to produce them, all as volunteer effort, he reported.

Council's first meeting was concluded, after all-day sessions, with an expression of welcome to two noted guests at the meeting, George F. Stickney, the Society's first Gold Medallist, and Reg. F. Michell, a member of the Council of the I.E.S. of Australia. Mr. Michell extended the greetings of that group, and expressed pleasure in the privilege of attending this Council meeting.

Executive Committee Actions

Meetings of the Council Executive Committee of I.E.S., not previously reported in IE, were held in August (at Pasadena, California) and on October 11, in New York City. A brief summary of actions taken at these meetings included:

Favorable action was taken at the Pasadena meeting on M. André Closset's request for aid in establishing a technical society on illuminating engineering in the Benelux countries. M. Closset, a member of I.E.S. from Brussels Belgium, described to the Committee the need for such an organization there, and indicated that translations of I.E.S. published reports, Recommended Practices, Guides and Constitution and By-Laws would be of assistance toward that end, in the considerations of a provisional organization committee.

The Executive Committee took action to make available a complete file of such published material to assist in the formation of a technical society on illuminating engineering in the Benelux countries.

Study on the scope of the Television Committee was reported, and action taken to establish its scope as: "study and report on the lighting for the optical reception of television programs," in which work the Society would continue to cooperate with the Society of Motion Picture and Television Engineers.

At the October 11 meeting, President Sturrock reported on a request from Robert Clark, Director of the Manpower Office, National Security Resources Board to "secure the advice and judgment of the scientific profession to make formal recommendation to the NSRB with regard to policies and procedures to bring about the most effective utilization of America's highly trained scientists. Action was taken by the Committee to recommend the appointment of A. F. Wakefield, Chairman of the Society's Coordinating Committee for Defense, as the I.E.S. representative to the National Research Council in connection with the matter.

NEW OFFICERS for the New Orleans Section of I.E.S. were installed at a dinner meeting held at the New Orleans Athletic Club. Shown above to the left is Ben Z. Segall, incoming Chairman, receiving the gavel of office from retiring Chairman Harold L. Salaun.

Iowa Section Holds Fall Conference

For some years past, outstanding conferences on illumination have been conducted four times a year by the Iowa Section of I.E.S., attracting visitors from a wide surrounding territory. Their Fall Conference held September 15 at the President Hotel, Waterloo, Iowa, featured a full day's program, presenting four outstanding papers and numerous discussion sessions.

C. O. Christensen, Chairman of the Iowa Section, opened the meeting; Address of Welcome was by Merle Poor, President of the Iowa Public Service Co., Eastern Division, Waterloo, Iowa. The program of papers, arranged by Giles Crider as Program Chairman, included:

"Engineered Lighting with Prismatic Lenses," by J. A. Toohey, District Manager, Holophane Co., Inc., Evanston, Ill.

"A New View of Lighting," by William Weibel, Illuminating Engineer, Curtis Lighting, Inc., Chicago, Ill.

"Homelighting Practices ... Today ... Tomorrow," by Richard H. Haase, District Engineer, Iowa-Illinois Sales District, Lamp Dept., General Electric Co., Davenport, Iowa.

"A Chance to Play" A "March of Time" Sound Film on Sports Lighting. Courtesy of General Electric Company.

"Conferences Summary," C. O. Christensen.

Sociability Hour — Hosts: Crescent Electric Supply Co., Iowa Public Service Company, Westinghouse Electric Supply Company.

Banquet.

An additional attraction for the Conference delegates was an inspection trip conducted by Charlie Gehan and Merle Jones of the Iowa Public Service Co., during which outstanding lighting installations in Waterloo were visited.

Rocky Mountain Section Receives Charter

A double ceremony of some significance marked the first meeting of the Rocky Mountain Section (née Chapter) in September. Incoming officers were formally installed; the Section's new Charter was presented with appropriate ceremony.

J. M. Ketch of General Electric Co., Nela Park, who presented the original Chapter Charter in 1941 came to Denver to repeat the ceremony, and present to the incumbent Chairman, Howard C. Ernst, the new Charter.

Additional formalities attended the presentation by Mr. Ernst, of the Charter, along with the traditional gavel to the incoming 1950-51 Chairman, Harold Rankin.

The meeting and dinner at the El Rancho Restaurant was attended by some 60 members and their wives.

CHARTER presentation ceremonies were a feature of the first meeting of the Rocky Mountain Section in Denver. Jim Ketch (center) presents the Charter to Howard C. Ernst, retiring Chairman (right) while incoming Chairman Harold Rankin (left) looks on.

Medal Nominations Invited

The 1951 Medal Committee, G. W. Reals, Chairman, is currently alerting the membership, and the officers of all Sections and Chapters, that nominations are invited for consideration by the Committee.

"Candidates for the award need not be members of the Society, nor citizens of the United States or Canada, and may be nominated at any time by any member of the Society, by presenting the Committee on Award the name of the individual whose accomplishments in his field are deemed worthy of such recognition. Each nomination should be accompanied by a comprehensive statement of the candidate's achievements, whether it be in the field of engineering, applied illumination, optics, ophthalmology, lighting research, education, or administration and management.

"In order for a candidate to be considered for the award of a given year, the following shall be delivered at the General Office before January 1 of that year:

a. A letter requesting consideration of the proposed candidate.

b. A statement of the candidate's achievements, on which the recommendation is based. This statement shall be signed by the person responsible for the information, not necessarily a member of the Society."

Nominations should be sent to the I.E.S. Medal Committee in care of the General Office of the Society. Inquiries concerning nominations may be addressed to the Executive Secretary, A. D. Hinckley.

Deadline Set for 1951 Conference Paper Outlines

The I.E.S. Papers Committee has announced that a deadline date of February 1, 1951 has been established for the receipt from authors of outlines of their proposed papers for the 1951 National Technical Conference at Washington, D. C. Outlines received from authors after this date may not receive consideration. Outlines of proposed Conference papers should be mailed (by February 1) to: Hoyt P. Steele, Chairman Papers Committee, % Benjamin Electric Mfg. Co., Des Plaines, Illinois.

After a prospective author receives a tentative approval of the outline for his proposed paper he will be expected to mail his manuscript to the Chairman of the Papers Committee by April 1, 1951.

It has been necessary to establish these firm deadline dates in order to give proper time for publication and for serious consideration by potential discussors. A rigid publication schedule makes any later dates impossible, especially in 1951 when the National Technical Conference is scheduled for the week of August 27.

Congress Librarian and Capitol Architect Sponsor Work Environment Lecture Series

A series of five lecture and discussion programs devoted to the subject of the relation of environment to work will be presented in the Coolidge Auditorium of the Library of Congress during the week November 6 through 10. Luther H. Evans, Librarian of Congress, and David Lynn, Architect of the Capitol, are co-sponsors of the series. Nationally recog-

nised experts have agreed to present papers reflecting the latest developments in their respective fields of specialization. The major environmental subjects to be included are illumination, sound control, ventilation, color engineering, and safety.

The lectures were originally intended for the benefit of those who are particularly concerned with planning future improvement programs for offices on Capitol Hill. However, in view of the wide spread interest which attaches to this subject, and the unusual competence of the speakers who have agreed to participate, arrangements are being made to accommodate a broadly representative audience from the Federal Government, labor organizations, the business community, scientific and professional associations and other groups.

Two lectures of the series are devoted to illumination and its relation to work environment. On Monday, November 6, Willard Brown will open the series with a discussion of "Seeing Conditions Important to Productive Effort." Mr. Brown is a former national president of I.E.S. and has served as Director of the Secretariat on Lighting Practice for the International Commission on Illumination. He is presently manager of the Engineering Division of the Lamp Department, General Electric Company.

Mr. Brown will be assisted by Robert L. Oetting, who is similarly recognized as an authority in this field and has served as a consultant on many of the larger office lighting projects since the war.

S. W. Quisenberry will present "The Case for Color" on Tuesday, November 7. Mr. Quisenberry is a member of I.E.S., the American Standards Association, and the Physical and Psychological Factors Committee of the National Office Management Association. He has written extensively on the subject of color engineering and is presently associated with the E. I. duPont de Nemours and Company.

Other lectures included in the series will cover "Noise as an Environmental Distraction and Hazard" by R. A. Wilson of the Celotex Corp., on November 8; "Principal Aspects of Air Conditioning" by Charles S. Leopold, on November 9; and "The Conservation of Manpower Through Accident Prevention" by E. R. Landry, Safety Director for the U. S. Post Office Department. Mr. Landry's lecture, on Friday, November 10, will also give a brief general review of the five lectures designed to emphasize the many interrelationships which are to be found between the major factors of environment and their importance in furthering the comfort, morale, and effectiveness of the individual.

Attendance at the lectures will be by invitation.

LIGHTING CALENDAR

Society Events

December 14, 1950 — Meeting of I.E.S. National Council, New York, N. Y.

February 8, 1951 — Meeting of I.E.S. National Council, New York, N. Y.

March 4-6, 1951 — Southwestern Regional Conference, Corpus Christi, Texas

March 12-16, 1951 — South Pacific Regional Conference, San Francisco, Calif.

March 19-24, 1951 — Pacific Northwest Regional Conference, Spokane, Wash.

April 5, 1951 — Meeting of I.E.S. National Council, Chicago, Ill.

April 9-13, 1951 — Canadian Regional Conference, Chateau Frontenac, Quebec

May 14, 1951 — Midwestern Regional Conference (Hotel and City not yet announced).

May 21, 1951 — Great Lakes Regional Conference, Cincinnati, Ohio

June 14, 1951 — Meeting of I.E.S. National Council, New York, N. Y.

August 26 - August 30, 1951 — Illuminating Engineering Society, National Technical Conference, Hotel Shoreham, Washington, D. C.

Industry Events

November 13-16, 1950 — National Electrical Manufacturers Association, Chalfonte-Haddon Hall, Atlantic City, N. J.

November 3, 1950 — Annual Meeting, RLM Standards Institute, Inc., Statler Hotel, Cleveland, Ohio

November 27 - December 1, 1950 — The American Society of Mechanical Engineers, Annual Meeting, Hotel Statler, New York, N. Y.

November 27-29, 1950 — American Standards Association, Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

November 27 - December 3, 1950 — Power Show, Grand Central Palace, New York, N. Y.

December 3-6, 1950 — The American Society of Refrigeration Engineers, 46th Annual Meeting, Hotel Commodore, New York, N. Y.

December 26-30, 1950 — 117th Meeting of the American Association for the Advancement of Science, Cleveland, Ohio

January 15-18, 1951 — Plant Maintenance Show, Cleveland, Ohio

January 22-25, 1951 — The American Society of Heating and Ventilating Engineers, 57th Annual Meeting, Philadelphia, Pa.

January 22-26, 1951 — *Winter* General Meeting, American Institute of Electrical Engineers, New York

February 28, 1951 — Inter-Society Color Council, Annual Meeting, Washington, D. C.

March 5-9, 1951 — Spring Meeting and Committee Week of the American Society for Testing Materials, Cincinnati, Ohio

March 12-15, 1951 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

April 2-5, 1951 — The American Society of Mechanical Engineers, Spring Meeting, Atlanta, Ga.

April 3-5, 1951 — 17th Annual Sales Conference, Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.

Week of May 20th, 1951 — National Association of Electrical Distributors, Atlantic City, N. J.

June 4-7, 1951 — Edison Electric Institute, 19th Annual Convention, Denver, Colorado

June 11-15, 1951 — The American Society of Mechanical Engineers, Toronto, Ont., Canada

June 25-29, 1951 — Summer General Meeting, American Institute of Electrical Engineers, Royal York Hotel, Toronto, Ont., Canada

September 25-28, 1951 — Fall Meeting, The American Society of Mechanical Engineers, Minneapolis, Minn.

October 8-12, 1951 — 39th National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

November 12-15, 1951 — National Electrical Manufacturers Association, Chalfonte-Haddon Hall, Atlantic City, N. J.

November 28-30, 1951 — Annual Meeting, The American Society of Mechanical Engineers, Atlantic City, N. J.

Ostwald Color Harmony Manual Matched in Paints

The development of paints in flat, semi gloss, enamel, and sealer finishes to match all the color samples in the Ostwald Color Harmony Manual was announced recently by the Martin-Senour Co. and the Container Corporation of America. For these paints, Ostwald color designations of the color scheme desired, may be specified to the paint dealer, and the paint will be mixed according to exact specifications. The match of the paint to the chip will be true under all conditions of illumination ranging from incandescent light to daylight, according to the announcement. All paint mixtures are made from six basic color pigments plus white and a greying agent.

A table giving the I.C.I. specifications, including reflectance values, of all of the color chips in the Manual is expected to be available soon, through the Container Corporation. This is expected to be of value to decorators and illuminating engineers in specifying the reflection factors for wall and ceiling finishes to obtain maximum benefit from lighting installations.

Blackouts Passée?

Time magazine in its October 16 issue noted that "Blackouts will not be used so extensively as in World War II because radar can spot a target in the darkness."

National Restaurant Association Joins I.E.S. to Study Food Service Areas

A study of special significance to the public welfare, and with an interesting history of intra-industry cooperation is now under way by the newly-appointed I.E.S. Committee on Lighting in Kitchens, Lunchrooms, Cafeterias and Dining Areas.

Assisting and advising the Committee will be representatives of the mass feeding and mass housing fields. Actual lighting installations in operating commercial institutions will be made by the committee to test, revise and finally establish standard practice.

Indicative of the great need of lighting standards in the food service industry — as well as of the willingness of mass feeding and housing and technical organizations to cooperate in such a study, is the chain of events leading to the establishment of the committee. Initial impetus came in a letter to Leonard V. James, illuminating engineering consultant of Chicago, from the North Carolina Board of Health, requesting standards by which to judge the lighting for their own food service departments.

Inquiries disclosed that no such standards had ever been established; installations were being made on the recommendations of individual engineers, architects and owners, but no authoritative body had ever prepared approved standards based on careful research.

A consultation between Mr. James and the editorial staff of *Institutions* magazine resulted in the decision to propose an investigation leading to such a standard by a committee representing the Illuminating Engineering Society, and sponsored by a responsible industry organization.

Colonel Paul P. Logan, director of food and equipment research for the National Restaurant Association was consulted. Colonel Logan immediately gave the project his full approval and has contributed substantially to setting the stage for a complete and careful study of the subject.

Carl W. Zersen, managing director of the Chicago Lighting Institute accepted the chairmanship of this committee. Working with him are: Robert D. Burnham, engineer and consultant, Chicago Lighting Institute; George Gilleard, assistant chief engineer, Curtis Lighting, Inc.; Arthur P. Larson, testing engineer, Commonwealth Edison Co.; Charles T. Masterson, engineer and architect, Lamp Dept., General Electric Co.; Edwin L. Riego, electrical engineer, Marshall Field and Co.; Maurice W. Ross, director of commercial engineering, Commonwealth Edison Co.; Lawrence A. Witt, commercial engineer, Public Service Company of Northern Illinois; Edward J. Wolff, vice president in charge of engineering, Electric Service Engineering Co., Chicago.

This group officially is a subcommittee of a general "Committee on Lighting Study Projects in Public Buildings and Private Institutions" of which Robert S. Rogge of Detroit is chairman. Mr. James has been appointed a member of this general committee with particular responsibility for the activity of the local subcommittee.

The matter was brought to the attention of leaders in the food service business in Chicago by Colonel Logan and several of them, enthusiastically endorsing the activity have agreed to assist the I.E.S. committee as an "advisory group."

The quarters of some of the leading dining establishments in Chicago have been offered as laboratories. The advisory group includes:

Colonel Paul P. Logan, director of food and equipment research, National Restaurant Association; James P. Harding, president, Harding Hotel and Restaurant Company; Robert F. Quane, general manager, The Stevens Hotel-Hilton Hotel Corporation; R. W. Steenberg, manager of restaurant division, Marshall Field and Company; Leo Lyons, director, St. Luke's Hospital; Florence Pope, director of residence halls, University of Chicago; Dr. Harvey J. Finison, staff and faculty, Armour Research Foundation, Illinois Institute of Technology; Frank O. Washam, director of food service, Board of Education, Chicago Public Schools; C. L. Staples, Managing Editor, *Institutions Magazine*.

Procedural detail of the program has not yet been determined. It is probable that kitchens will be studied first, as the problems are more concrete there than in dining areas, and the solutions more quickly established. Members of the I.E.S. Committee expect to inspect the kitchen operations closely, determine the critical details in the visual tasks, reproduce some of these details in the laboratories of the Chicago Lighting Institute, try what seem to be obvious solutions and finally determine the best use of lighting equipment and other surfaces for each particular operation. From time to time the solutions will be demonstrated to the advisory group.

LIGHTING of food service areas is a new study now underway in cooperation with the National Restaurant Association. Shown during the preliminary discussions are (l. to r.) Carl Zersen, Chairman; Col. Paul Logan, N.R.A., J. B. Harding, Pres. of Harding Hotel, and L. V. Jones, consulting engineer.

Fluorescent Lighting Installed In Underpass

The first underpass installation of fluorescent lighting in the midwest has recently been completed in Indianapolis, Indiana.

According to James D. Blythe of the Indianapolis Power & Light Company, 14

new type fluorescent luminaires have been installed in the recently completed Kentucky Avenue underpass of the Indianapolis Union Railway Company. Especially designed for tunnel and underpass illumination, the units used consist of an anodized aluminum reflector in which a 6-foot slimline lamp is mounted, and a clear plastic cover hinged to permit servicing and relamping. Mounted end to end, the luminaires provide a practically continuous path of light along the length of the underpass.

OBITUARY

Professor Harry O. Warner, director of the University of Detroit's Department of Engineering for thirty years and a past-chairman of the Michigan Section of the I.E.S., died September 15th in his home of a heart ailment.

Professor Warner was born in Royalton, Pennsylvania in 1890. After graduating with a B.S. degree from Penn State College in 1914, Professor Warner became associated with the Engineering Department of the Bell Telephone Co. of Pennsylvania where he remained until 1919. At that time he accepted a teaching position in electrical engineering at George Washington University. The following year he became Department Head in Electrical Engineering at the University of Detroit — a position he held for thirty years becoming the oldest person in the point of service in the University's College of Engineering. During his teaching career, Professor Warner received his E.E. degree from Penn State College and his master's degree from the University of Michigan in 1936.

Long prominent in engineering circles as both teacher and consultant, Professor Warner was also active in a number of organizations. He was chairman of the Sub-committee on Research of the I.E.S., a member of the committee on Instruments and Measurements for the Michigan Section of the American Institute of Electrical Engineers, and of the engineering fraternity, Sigma Rho Tau, the Engineering Society of Detroit.

He is survived by his wife, Margaret and daughter, Elizabeth Ann.

Lawrence F. Wooster, Professor of Electrical Engineering at Oregon State College, and a member of the Oregon Section of I.E.S. since its founding, died in Corvallis on June 14th. He was to have retired on July 1st.

Born in Litchfield, Illinois in 1884, Professor Wooster received his degree of Bachelor of Science in Electrical Engineering at the University of Illinois in 1906. In 1910 he became an instructor at Oregon State College, receiving his Master of Science degree there in 1931. In addition to teaching applied electricity, he handled assignments for General Electric Company, Westinghouse Electric Corporation and the U. S. Army, and served as superintendent of light and power on the Oregon State College campus.

A past member of the Board of Managers of the Oregon Section, I.E.S., Professor Wooster was also a registered professional engineer, a member of Eta Kapp Nu, Kapp Delta Pi, and several civic fraternal organizations including the Masonic Lodge.

It was from Professor Wooster at Oregon State College that many Northwest illuminating engineers received their first introduction to the principles of illumination.

NEW MEMBERS

At the meeting of the Council held October 12, 1950 at the Hotel Lexington, New York City, the following were elected to membership:

ALAMO CHAPTER

Associate Members:
Miller, Elaine (Miss), 1067 Bandera Rd, San Antonio, Texas
Muruamo, J. B., General Electric Co., Lamp Dept., Corpus Christi, Texas

BALTIMORE CHAPTER

Associate Member:
Grempler, W. E., Pittsburgh Corning Corp., Pittsburgh, Pa.

BRITISH COLUMBIA SECTION

Member:
Walker, J. R., Provincial Government of B. C., Electrical Energy Dept., Vancouver

Associate Members:
Brassington, J. R., B. C. Elec. Railway Co., Ltd., Vancouver
Hutchings, J. G., Neolite Ltd., Vancouver
Mehler, Norman, Rainbow Lighting Co., Ltd., Vancouver

CAROLINAS CHAPTER

Associate Members:
Gilo, W. B., W. B. Gilo & Associates, Charlotte, N. C.
Hall, T. S., Noland Co., Inc., Durham, N. C.

CHICAGO SECTION

Members:
Fleischer, Joseph, City of Chicago, Bureau of Electricity, City Hall, Chicago
Frankel, Adolph, Westinghouse Elec. Corp., Chicago
Hjormstad, H. U., Sola Elec. Co., Chicago

Associate Members:
Colman, G. W., General Electric Co., Chicago
Dierker, W. W., Central Light Co., Springfield, Ill.
Freund, Emanuel, Morris Kurtzon, Inc., Chicago
Hintz, R. E., Central Ill. Public Service, Mattoon, Ill.
Kurtzon, Thomas, Curtis Lighting, Inc., Chicago
Mistretta, J. J., Chicago Park Dist., 425 E. 14th Blvd., Chicago
Schwartz, R. A. D., A. S. Schulman Electric Co., Chicago
Shaffer, J. R., Sola Elec. Co., Chicago
Tarnoff, N. H., Garden City Plating & Mfg. Co., 1750 N. Ashland Ave., Chicago

Continued on page 732

Street lighting in strict accord with I.E.S. Standard Practice for Street and Highway Lighting is underway for the streets of the City of Miami Beach, Florida. Before and after pictures of one street, Alton Road, emphasize the results of the improvement program. The installation is being made on recommendations submitted by A. C. Bergh, Chairman of the Southeast Florida Chapter.

COMMITTEES

COMMITTEES 1950-1951

Except as noted below, all committees are appointed by the President, subject to approval of the Council, and terminate at the time of the first Council meeting each new administration, in the month of October. The duties of each committee are indicated.
Walter Sturrock, President, ex-officio member of all committees.

STANDING COMMITTEES

BOARD OF FELLOWS — To evaluate the eligibility of candidates for transfer to the grade of Fellow and recommend their election by Council.
H. M. Sharp, Chairman, 82 Smallwood Drive, Snyder 21, N. Y.

Paul H. Goodell	H. H. Magdsick
Ward Harrison	G. F. Mudgett

J. L. Stair

COUNCIL EXECUTIVE — To conduct the affairs of the Society between Council meetings.
Walter Sturrock, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

R. F. Hartenstein	A. B. Manwaring
S. G. Hibben	E. M. Strong

FINANCE — Direct supervision of the financial affairs of the Society, present annual report on its financial condition and make recommendations to Council as to investments of money and upon all specific appropriations.
M. N. Waterman, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

R. F. Hartenstein	C. C. Keller

G. J. Taylor

GENERAL BOARD OF EXAMINERS — Evaluate the eligibility of applicants for admission to membership or transfer to the grade of Member and submit to Council their nominees for election to the grade of Member Emeritus.
E. M. Fahey, Chairman, Public Service Electric & Gas Co., 80 Park Place Newark 1, N. J.

Caroline E. Horn	T. O. Jorgensen

PAPERS — To procure, review and approve all technical papers and discussions thereof, for presentation before National Conferences of the Society.
Hoyt P. Steele, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.
H. W. Horn, Vice-Chairman, University of Illinois, 201 E. E. Annex, Urbana, Ill.

R. D. Bradley	G. E. Shoemaker
P. H. Hildebrand	H. L. Wright
Caroline E. Horn	R. R. Wylie
K. M. Reid	B. M. Zabel

PUBLICATIONS — To be responsible for the procurement, review and approval of all material for the publications of the Society other than technical papers approved by the Papers Committee for presentation at National Conferences of the Society and their discussions, and committee reports, for which it will have publication responsibility only. Shall also be responsible for the editing, printing and business management of the publications of the Society.
E. C. Huerkamp, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio
J. M. Stedman, Vice-Chairman, Pennsylvania Power & Light Co., 901 Hamilton Street, Allentown, Pa.

H. H. Magdsick	R. G. Slauer
R. W. McKinley	R. W. Stand

Sub-Committee on Advertising Sales
R. W. Stand, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

S. R. Naysmith	C. C. Shotwell
L. J. Rosier	G. J. Taylor
J. S. Schuchert	T. D. Wakefield

Sub-Committee on Editorial Content
H. H. Magdsick, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

C. A. Atherton	R. A. Palmer
O. P. Cleaver	H. M. Sharp
G. P. Dean	T. H. Shepherd
R. W. McKinley	T. D. Wakefield

Carl W. Zerner

Sub-Committee on Publication Sales and Distribution
R. W. McKinley, Chairman, 652 Morrison Drive, Mt. Lebanon, Pa.

Sub-Committee on Home Lighting Data Sheets
Edith Buchholtz, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

F. P. D'Esopo	Thomas S. Kelly
Mary E. Dodds	Ruth Morris
Lillian Eddy	Aileen Page
Stella Fetzer	Janet S. Reynolds
Anthony Fodell	Mary B. Taepke

Sub-Committee on Technical Data Sheets
H. P. Scott, Chairman, McGraw-Hill Publishing Co., 330 W. 42nd St., New York 18, N. Y.

Berlon C. Cooper	C. L. Crouch

GENERAL COMMITTEES

ADVISORY BOARD ON COMMITTEE PERSONNEL — To examine the organization, accomplishments, and assignments of committees and prepare not later than June 1st of each year a proposed list of committees and personnel.
S. G. Hibben, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

C. L. Crouch	A. D. Hinckley
C. H. Goddard	L. E. Tayler

BOARD OF NOMINATION — To prepare a nomination ticket containing the names of those who are deemed best suited to serve as officers and directors in positions to be filled at the ensuing election.
R. W. Stand, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

C. H. Goddard	L. E. Tayler

CONSTITUTION AND BY-LAWS — To prepare for Council amendments to the Constitution and By-Laws, as required, and to develop rules of procedure for the operation of the Society.
G. K. Hardacre, Chairman, Public Service Co. of Northern Illinois, 72 W. Adams St., Chicago 3, Ill.

Ralph Cheney	L. V. James
W. V. C. Foulks	C. N. Loupp

COORDINATING COMMITTEE FOR DEFENSE — To contact various Government Agencies concerned with National Security suggesting cooperation and participation in specific projects as an aid to solution of their problems. Recommending the placement of lighting study projects in present committees or the appointment of study project committees to the Society President and to expedite such study projects and guide accepted reports into proper Governmental channels.
A. F. Wakefield, Co-Chairman, The F. W. Wakefield Brass Co., Vermilion, Ohio
Major G. D. Mills, Co-Chairman, 243 Osborne Ave., Britannia Heights, Ottawa, Ont., Canada

J. W. Bateman	Henry B. Jones
O. P. Cleaver	Paul Manchester
C. L. Crouch	G. F. Mudgett
S. L. Drumm	K. M. Reid
Glenn A. Fry	John S. Walsh

M. N. Waterman

HISTORICAL — To assemble and make available for current reference and to prepare in suitable and durable form for posterity, such historical facts, printed memorabilia, photographs, voice records, museum specimens and allied items as may be judged worthy of composing a continuing digest of the record of the Society's history.
S. G. Hibben, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.
Mrs. W. F. Little, Librarian

George Ainsworth	L. H. Graves
George G. Cousins	Van R. Lansingh
H. B. Dates	George H. Stickney
Leo Dolhart	L. E. Tayler

LIGHTING SERVICE — To stimulate the discussion and practical application of lighting recommendations, standards, test procedures and other technical and scientific data developed by the Society to regional and local committees and to conduct a Lighting Service Forum in connection with the National Technical Conference.
L. E. Tayler, Chairman, The Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

H. A. Barnes	P. H. Hildebrand
Harry Grattan, Jr.	Roy A. Palmer

LOCAL ACTIVITIES — To coordinate regional and local activities with the national program of the Society, assist Section and Chapter officers with local operating problems, conduct Local Activities Conferences, prepare plan to give members a better understanding of the Society, review applications for the establishment of new Sections and Chapters and recommend the appointment of local representatives.
E. M. Strong, Chairman, Cornell University, Franklin Hall, Ithaca, N. Y.

Joe B. Browder	Charles N. Loupp
Floyd A. Covington	C. O. Martin
George F. Dean	J. S. Schuchert
K. E. Hollingsworth	R. G. Slauer

F. C. Winkler

MEDAL AWARD — To consider qualifications of candidates for I.E.S. Medal; submit recommendations to Council and prepare citation for the award.
G. W. Beals, Chairman, The Miller Company, Meriden, Conn.

W. C. Brown	J. L. Stair
G. G. Cousins	R. W. Stand
C. H. Goddard	L. E. Tayler
M. Luckiesh	J. S. Walsh

MEMBERSHIP — To develop plans and supervise the operation of the individual membership campaign in the Society.
J. H. Hull, Chairman, George C. Mittauer & Associates, 1300 47th Street, Des Moines 11, Iowa

NATIONAL TECHNICAL CONFERENCE — To supervise the 1951 Technical Conference, select the time and place for the 1952 and 1953 Technical Conferences and act as a depository of invitations for future conferences; study and report to Council the possibility of holding periodically a nationally sponsored technical conference for the Pacific Coast Zone.
R. F. Hartenstein, Chairman, Ohio Edison Company, Akron 8, Ohio
H. P. Steele, Vice-Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

R. B. Brady	D. W. Prideaux
W. C. Brown	J. S. Schuchert
George W. Clark	L. E. Tayler
J. C. Forbes	M. N. Waterman
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Conference Executive Committee
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Louis E. Barbrow, Vice-Chairman, National Bureau of Standards, Washington 25, D. C.
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Carl G. Estabrook	F. S. Walters
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PROCEDURES AND POLICIES — Analyze for Council current procedures and policies and make recommendations.
D. M. Jones, Chairman, Curtis Lighting Co. of Canada, Ltd., 19 Ballantyne Ave., Montreal, Que., Canada
C. H. Goddard — R. W. Staud
L. E. Tayler

PROFESSIONAL REQUISITES — To study and report on requisites for defining and improving the Professional Status of Illuminating Engineers, especially in reference to Society membership.
J. O. Kraehenbuehl, Chairman, University of Illinois, 201 E. E. Annex, Urbana, Ill.
Donald E. Trefry, Vice-Chairman, The Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

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Jos B. Browder	H. L. Logan
B. C. Cooper	E. M. Strong
Roy A. Eshelby	L. E. Tayler
W. H. Kahler	F. I. Wilson

PUBLIC RELATIONS AND INFORMATION — To prepare and disseminate information about the activities, accomplishments, programs, objectives and policies of the Society and about the place of illuminating engineering in modern society; to formulate and submit public relations policies and plans for the Society.
J. S. Schuchert, Chairman, Duquesne Light Co., 435 Sixth Ave., Pittsburgh 19, Pa.

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H. H. Green	John Ronayne
J. M. Hickerson	W. T. Stuart
P. F. Kauffman	L. W. Towner
James Krieger	George A. Watters
G. F. Mudgett	S. B. Williams

RESEARCH FUND — To sponsor the raising of funds for research.
L. E. Tayler, Chairman, The Detroit Edison Co., 2000 Second Avenue, Detroit 26, Mich.

A. H. Manwaring	R. W. Staud
R. A. Miller	S. B. Williams

RESIDENCE LIGHTING FORUMS — To reactivate and expand residence lighting forums, suggest programs for meetings, revise Guide for Residence Lighting Forums, and conduct a National Residence Lighting Forum Conference in connection with the National Technical Conference.
Janet S. Reynolds, Chairman, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

Denyse Beraha	Caroline E. Horn
Mary E. Dodds	Ruth Morris
C. I. Dwinell	Florence O'Donnell
Lillian E. Eddy	Priscilla Presbrey
Myrtle Fahsbender	Margaret Salter

Mary Taephe

SUSTAINING MEMBERSHIP — To obtain additional Sustaining Members.
C. C. Shotwell, Chairman, Philadelphia Electric Co., 1000 Chestnut Street, Philadelphia 5, Pa.

TASK COMMITTEES

TASK COMMITTEE — JOINT I.E.S. — A.P.H.A. COMMITTEE — To discuss with A.P.H.A. objectives of mutual interest in illumination, to review the relationship of light and vision, to study a rational basis for the quality and quantity of illumination and develop a list of researches desirable for further knowledge and cooperative effort.
E. M. Strong, Chairman, Cornell University, Franklin Hall, Ithaca, N. Y.

L. E. Barbrow	C. L. Crouch

Glenn A. Fry

TASK COMMITTEE ON ADVANCE PLANNING — To study the operation, program, publication activities, membership classifications and financial structure with a view of its immediate and long range objectives and to make recommendations to Council.
R. W. Staud, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

L. H. Graves	C. C. Keller
P. H. Hildebrand	J. E. Mueller
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M. N. Waterman

TASK COMMITTEE ON CONFERENCE WITH THE NATIONAL COUNCIL FOR SCHOOL-HOUSE CONSTRUCTION — To explore the field of mutual interest; to serve as a clearing house of expression regarding reports of both organizations; to study recommendations of quantity and quality of illumination and to develop a suggested program of study and research on specific illumination problems applying to schools.
R. C. Putnam, Chairman, 2223 S. Overlook Road, University Center Station, Cleveland 6, Ohio

L. H. Brown	W. V. C. Foulks
C. L. Crouch	L. B. Paist

TASK COMMITTEE TO STUDY POSSIBLE CHANGE IN I.E.S. FISCAL YEAR
B. C. Cooper, Chairman, McGraw-Hill Publishing Co., 330 W. 42nd St., New York 18, N. Y.

L. H. Graves	E. M. Strong
A. H. Manwaring	M. N. Waterman

S. B. Williams

TECHNICAL COMMITTEES

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Lewis B. Moore, Chairman, The Grimes Manufacturing Co., Urbana, Ohio

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COLOR AND ILLUMINATION — To study, evaluate and report on the effect of color in relation to the art and science of illumination.
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DAYLIGHTING — To study the problems involved in daylighting, develop recommended practices and report thereon.
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FARM BUILDINGS AND WORK AREA LIGHTING — To study the application of light and lighting of farm buildings, surrounding work areas and other rural locations and to report thereon.
P. H. Hildebrand, Chairman, Pennsylvania Power & Light Co., 9th & Hamilton Streets, Allentown, Pa.

O. D. Hunt	
T. M. Barr	
Edith Buchholtz	Arthur Kramer
J. P. Ditchman	Joseph Schaenzer

A. J. Von Burg

HANDBOOK REVISION — To revise and arrange the technical content of the Handbook; to lay out, plan and arrange for development of individual sections primarily through appropriate technical committees; to establish and maintain liaison with the Publications Committee with reference to production matters and the preparation of a budget which will be submitted by the Publications Committee to Council for approval; to be responsible to Council for the technical accuracy and treatment of material to be turned over to the Publications Committee for publication.

B. J. Jensen, Chairman, Public Service Electric & Gas Co., 80 Park Place, Newark 1, N. J.

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C. L. Cottrell	M. N. Waterman

D. M. Jones

ILLUMINATION PERFORMANCE RECOMMENDATIONS — To prepare illumination performance recommendations for luminaires conforming to I.C.I. classifications, excluding residential.

Ray P. Teele, Chairman, 3713 Jenifer Street, N. W., Washington 15, D. C.

B. S. Benson, Jr.	W. F. Little
S. K. Guth	J. F. Parsons
W. H. Kahler	R. S. Rogge

G. P. Wakefield

INDUSTRIAL LIGHTING — To revise the 1942 "American Recommended Practice of Industrial Lighting" with full consideration to the brightness approach, and with Council approval, to submit for American Standards Association approval.

W. C. Brown, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

E. A. Lindsay, Secretary

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W. P. Lowell, Jr.	M. N. Waterman

LIGHT CONTROL AND EQUIPMENT DESIGN — Collect and correlate the knowledge and data on means and methods of controlling, directing, reflecting, transmitting, and diffusing light and on the principles and practices of equipment design.

R. D. Bradley, Chairman, Day Brite Lighting, Inc., 5411 Bulwer Street, St. Louis 7, Mo.

D. L. Williams, Vice-Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

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B. S. Benson, Jr.	J. C. Wilson
Kurt Franck	F. C. Winkler

LIGHT SOURCES — To correlate and report available information as to the physics of light and light production and the characteristics of current light sources.

E. F. Lowry, Chairman, Sylvania Electric Products, Inc., 126 Washington St., Salem, Mass.

E. H. Raddin, Vice-Chairman, 18 Smith Road, Saugus, Mass.

Louis E. Barbrow	Arthur C. Downes
Howard J. Berka	G. S. Evans
James Cox	B. F. Greene
H. F. Davidson	A. B. Oday

E. H. Salter

LIGHTING AND AIR CONDITIONING — To study the relationship between lighting and various factors that enter into air conditioning and report thereon.

E. H. Salter, Chairman, 182 Cleveland Avenue, Great Kills, Staten Island, N. Y.

S. A. Bogen	R. R. Lusk
Maurice Cook	H. M. Sharp

LIGHTING AND ARCHITECTURE — To study the application of light and lighting in the field of architecture. To plan an interchange of knowledge and data between the architectural profession and the I.E.S. To plan and develop lighting design competitions in architectural schools. To report to the Society on assignments falling within this scope.

W. M. Potter, Chairman, General Electric Company, Nela Park, Cleveland 12, Ohio

Creston Doner	Douglas Maier
Ray Hurley	O. W. Meissner
Lucian T. Kight	Arthur H. Molitor

J. F. Watkins

LIGHTING DESIGN PRACTICE — To study published data on coefficients of utilization, room indexes, maintenance coefficients and other elements entering into calculations for lighting design, develop standard methods for use in Society publications and report thereon.

Neal Jacobus, Chairman, 407 Jackson Building, Buffalo 2, N. Y.

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B. S. Benson, Jr.	J. J. Neidhart
J. H. Dean	J. F. Parsons
J. R. Jones	R. S. Rogge

E. H. Salter

LIGHTING EDUCATION — To prepare educational and training programs on the fundamentals of illumination, lighting design problems and advance theories of light and lighting application. To prepare required text material and to further their adoption locally.

C. E. Weitz, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

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O. D. Whitwell

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J. F. Parsons, Chairman, Niagara Mohawk Power Corp., 802 Electric Building, Buffalo 3, N. Y.

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B. S. Benson, Jr.	R. E. Ligare
George D. Clayton	R. R. Lusk

A. A. Sobolik

LIGHTING OF CENTRAL STATION PROPERTIES — To study and report on the lighting of electric power generating plants and their power distribution facilities.

A. A. Brainerd, Chairman, Philadelphia Electric Co., 900 Sansom Street, Philadelphia 5, Pa.

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R. M. Graves	D. W. Taylor

D. H. Tuck

LIGHTING MAINTENANCE — To study the elements contributing to maintenance factors; set up the framework of typical field studies to determine factors; and to stimulate the prosecution of such studies by appropriate agencies.

D. C. Freeman, Chairman, 4330 Davenport Street, N. W., Washington 16, D. C.

Eric H. Church, Vice-Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

A. C. Barr	E. F. Lowry
R. L. Biesele, Jr.	R. S. Rogge
E. W. Fowler	R. P. Teele

G. P. Wakefield

LIGHTING STUDY PROJECTS IN INDUSTRY — To initiate, follow up and coordinate lighting study projects in the industrial field, review the reports of the various sub-committees in this field and make recommendations to Council.

E. W. Fowler, Chairman, Buffalo Niagara Electric Corp., 805 Electric Bldg., Buffalo 3, N. Y.

J. B. Chambers	Shirley Hulse
C. E. Egeler	W. H. Kahler
C. D. Hollister	W. P. Lowell, Jr.

J. P. Parks

Lighting in the Canning Industry

Carl O. Martin, Chairman, Benjamin Electric Mfg. Co., 829 Folsom St., San Francisco 7, Calif.

L. H. Brown	R. S. Prussia
S. H. Hazleton, Jr.	Robert Thallon
K. M. Noble	David C. White

H. K. Wilder

Lighting for Cleaning and Dyeing Industry

Frank Walters, Chairman, Potomac Electric Power Co., 10th & "E" Sts., N. W., Washington 4, D. C.

Lighting in the Fluid Milk Industry

O. A. Hill, Jr., Chairman, Public Service Co. of No. Illinois, 1701 S. First Avenue, Maywood, Ill.

Lighting in Foundries

Frank E. Mueller, Chairman, 1296 Nicholson, Lakewood 7, Ohio

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A. L. Collier	J. H. Lansing

J. W. Steiner

Lighting in Laundries

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W. S. E. Miller

Lighting for Rubber Industry

L. O. Banahan, Chairman, Ohio Edison Co., 47 N. Main St., Akron 8, Ohio

Lighting in Sheet Metal, Stamping, Folding and Shearing

Floyd W. Sell, Chairman, The Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

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E. L. Frase	Ted Roughley

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C. M. Cryster	Lucian T. Kight
C. J. Enlind	H. J. Mazur

Carlton Ostrom

Supplementary Lighting

W. H. Kahler, Chairman, Westinghouse Electric Corp., 1216 W. 58th Street, Cleveland 3, Ohio

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L. E. Goble	R. E. Mauk

Lighting in the Textile Industry

W. L. Kelley, Jr., Chairman, 77 Bayley Street, Pawtucket, R. I.

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L. A. Kline	F. E. Singleton
Walter P. Rayner	F. J. Vorlander, Jr.

J. E. Watkins

Lighting for Woodworking Industry

Walter S. Gorden, Jr., Chairman, 108 E. 11th, Tacoma 2, Wash.

LIGHTING STUDY PROJECTS IN PUBLIC BUILDINGS AND PRIVATE INSTITUTIONS — To initiate, follow up and coordinate lighting study projects in the field of public buildings and private institutions, review the reports of the various study sub-committees in this field and make recommendations to Council.

R. S. Rogge, Chairman, 9117 Prevost Avenue, Detroit 28, Mich.

L. V. James	J. M. Ketch
J. R. Jones	A. C. Sangster

C. C. Shotwell

Lighting in Auditoriums and Churches

David H. Mason, Chairman, Mason & Basedow, 1415 W. Adams St., Chicago 7, Ill.

Louis Gold	W. B. Kennedy
H. C. Jones	Chas. W. McCormick

Edward Rambusch

Lighting in Hospitals

Howard Haynes, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

H. W. Alexander	Harry Grattan, Jr.
D. L. Angus	E. H. Greppin
J. C. Connor	N. L. Griffin
B. C. Cooper	J. J. Neidhart
W. J. Engle	Floyd W. Sell

Albert Zack

Lighting in Kitchens, Lunchrooms, Cafeterias and Dining Areas

Carl Zerseu, Chairman, 241 Schiller Street, Elmhurst, Ill.

Robert D. Burnham	E. L. Riego
George Gilleard	M. W. Ross
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Frank O. Washam

Lighting in Theatres

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Theodore Fuchs — Hunton D. Sellman
J. S. Hamel — George Smedberg
S. G. Hibben — Daniel Stackle
Herbert Kliegl — R. Gillespie Williams
James McCulloch — Frederick M. Wolff

NOMENCLATURE — To define the terms and standards of illumination; and endeavor to obtain uniformity in nomenclature.
Harris Reinhardt, Chairman, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.
J. O. Kraehenbuehl, Vice-Chairman, University of Illinois, 201 E. E. Annex, Urbana, Ill.
A. Abramowitz — S. K. Guth
E. Q. Adams — L. A. Jones
C. L. Cottrell — W. F. Little
H. P. Gage — Priscilla Preshrey
K. S. Gibson — H. P. Steele
C. C. Shotwell

OFFICE LIGHTING — To study the lighting requirements of office lighting tasks, develop suitable lighting recommendations and report thereon.
G. P. Wakefield, Chairman, The F. W. Wakefield Brass Co., 731 S. Water St., Vermilion, Ohio
G. F. Dean, Vice-Chairman, Toronto Hydro-Electric System, 14 Carlton St., Toronto, Ont., Canada
A. S. Almrydo — R. W. McKinley
C. T. Bahcman — John Neidhart
L. M. Endres — R. L. Oetting
W. E. Folsom — T. H. Shepherd
G. C. Fowler — George J. Taylor
Harry Keene — Roger T. Waite
C. W. Macy — R. L. Zahour

Project Committee on Characteristics of Office Materials and Equipment and Related Environmental Factors

A. S. Almrydo, Chairman, 922 Reba Place, Evanston, Ill.
R. A. Thomas, Vice-Chairman, General Electric Co., 901 Genesee Bldg., Buffalo 2, N. Y.
W. C. Granville — H. J. Mahaffey
J. G. L. Walden

Project Committee on Depreciation and Maintenance of Office Lighting Systems

G. P. Wakefield, Chairman, The F. W. Wakefield Brass Co., 731 S. Water St., Vermilion, Ohio
J. H. Murrah — George J. Taylor

Project Committee on Performance of Lighting Systems

G. C. Fowler, Chairman, Public Service Co. of No. Illinois, P.O. Box 278, Glencoe, Ill.
C. W. Macy — J. H. Murrah
H. J. Mahaffey — James P. Warner

Project Committee on Recommendations for Specific Areas

G. F. Dean, Chairman, Toronto Hydro-Electric System, 14 Carlton St., Toronto, Ont., Canada
A. S. Almrydo — John Neidhart
Walter J. Lind — Harris Reinhardt
C. W. Macy — R. G. Rudrow

Project Committee on Task Evaluation

R. L. Oetting, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio
George J. Taylor

PROGRESS — To keep in touch with developments in the art of lighting throughout the world and prepare a yearly review of achievements in the art of illuminating engineering for inclusion in ILLUMINATING ENGINEERING.
Alston Rodgers, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio
T. C. Sargent, Vice-Chairman, Sylvania Electric Products, Inc., 60 Boston Street, Salem, Mass.
E. W. Beggs — Thomas S. Kelly
M. H. Bigelow — Arthur P. Larson
O. P. Cleaver — J. A. Meacham
T. F. Coghlan — J. W. Steiner
Kurt Franck — George J. Taylor
B. F. Greene — F. W. Tetzlaff
P. H. Hildebrand — A. S. Tyler

Foreign Correspondents

Jean Jacques Chapuis — France
Ivar Folcker — Sweden
L. C. Kalff — Holland
E. B. Sawyer — England

PROTECTIVE LIGHTING — To prepare standards for protective lighting of plants, yards, boundary fences, adjoining highways, railroad sidings, and waterway approaches for the purpose of reducing fire and theft risks, and making policing more effective.
J. W. Lee, Chairman, Philadelphia Electrical & Mfg. Co., 1236 N. 31st Street, Philadelphia 21, Pa.
J. C. Forbes — Van Edward Marker
M. C. Hatch — Gene Rae
H. E. Mahan — Dana W. Rowten

PUBLIC CONVEYANCES — INTERIOR LIGHTING — To study the application of light to all public areas in conveyances used for passenger transportation, including particularly trains, buses, ships, street railways and subways and report thereon.
E. W. Beggs, Chairman, Westinghouse Electric Corporation, Bloomfield, N. J.
A. L. Arenberg — E. B. Hallman
Charles I. Brady — E. Hatch
F. P. Brown — J. L. Heine
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Continued on page 15A

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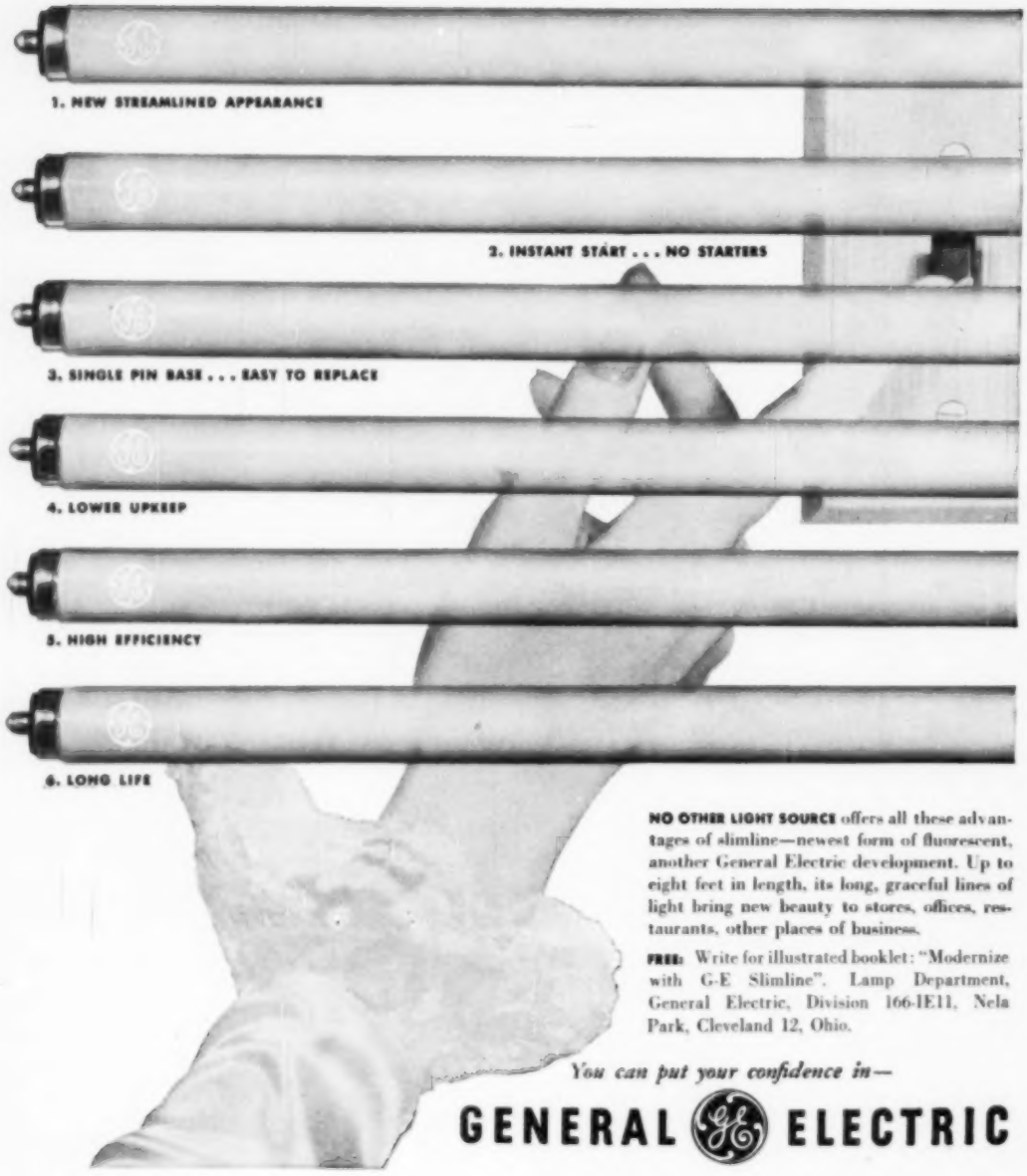
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Practical Schoolroom Brightness Ratios

THE latest concepts of brightness control in schoolrooms have attracted the attention of educators, architects, and illuminating engineers. This interest has been increased by the recommendations in the 1948 publication of the American Standard Practice for School Lighting. The practicability of these recommendations for brightness ratios and reflectances will be confirmed by experience. The results of a recent investigation are particularly timely as they demonstrate that the recommendations for artificial lighting can be met through the use of materials readily available.

In April 1948 a school in Mansfield, Ohio, was remodeled through the installation of new luminaires, new desks of a lighter wood finish, and through the repainting of all interior surfaces. Between the time of installation and late November when the survey was made, the room had minimum maintenance. The lighting equipment had not been cleaned, the diffusers on the windows had not been dusted, and the paint had not been touched up. One fluorescent lamp had been replaced. The only depreciation noted was three small particles showing as dark spots on the plastic luminaires and several heel marks on the lower wall.

The survey was taken November 26, 1948, 2:30 to 4:30 in the afternoon. The daylight component was comparatively small during the time that the measurements were taken, as the afternoon was dark and cloudy with light rain. The windows were not provided with shades since the daylight diffusers were designed to reduce sky brightness.

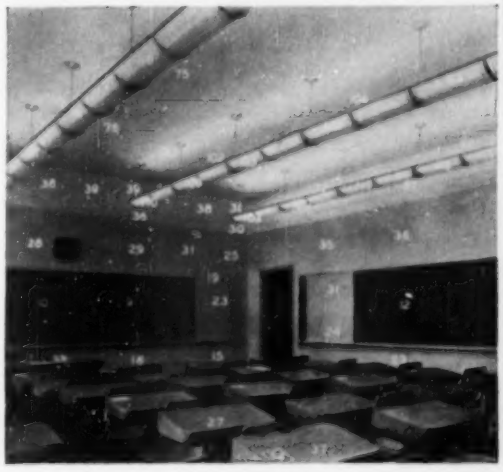
Brightness measurements were taken by use of a Luckiesh-Taylor Brightness Meter. The observer was seated in a rear corner of the room nearest the windows. The brightness readings superimposed on the photograph represent, therefore, the brightness pattern in footlamberts as seen from the particular position on a dark day in late November. On the basis of these readings, the comparison of the brightness ratios to the recommendations for limits of brightness ratios given in the 1948 American Standard Practice for School Lighting (Table I) give values well within the required limits.

The lighting level is well above the required minimum of 30 footcandles, the lowest value recorded (38 footcandles) being on the desk top in the rear corner of the room farthest from the windows.

The reflectances (Table II) obtained by use of a Baumgartner Reflectometer agree closely with the recommendations. The few cases where the reflectances are above the recommended range seem desirable in regard to brightness ratios.

The room is of standard size, 30 x 22 x 12 feet. The luminaires are of the luminous indirect type with plastic reflectors, each unit equipped with two 40-watt 3500° white fluorescent lamps. The 24 units are mounted in four continuous rows.

The qualities of visual comfort which the room possesses are indicated by the various brightness ratios. The natural finish wood desk top with reflectances averaging 42 per cent gives a very low brightness ratio when the visual task involves white paper with average reflectances of 60 per cent to 70 per cent. Visibility comments favorably on the slight variation in brightness between the luminaires and the surfaces adjacent to them.



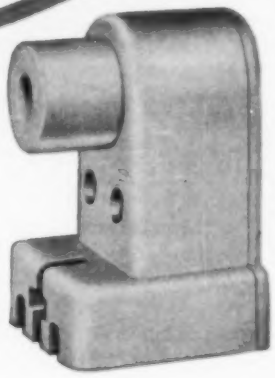
Brightness pattern in footlamberts, John Simpson Junior High School, Mansfield, Ohio. Figures represent brightness values in footlamberts.

THE F. W. Wakefield BRASS CO.
VERMILION, OHIO

FOR NEW UNIVERSAL TYPE SLIMLINE LAMPHOLDERS

FLUSH OR SURFACE MOUNTING

THE ANSWER IS BRYANT



No. 4377
660 Watts
1000 Volts
(Flush Mounting)

These slimline lampholders, made of white urea, will accommodate T-6, T-8 and T-12 slimline lamps.

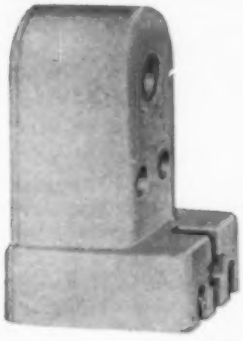
The terminals in both the high and low voltage lampholders are arranged to permit straight-in wiring . . . a most desirable feature.

The recessed binding screws are staked and backed out.

Spring-actuated plunger in the high voltage lampholder allows for ¼-inch variation in lamp length and ½-inch variation in lampholder mounting.

Single screw mounting with slot in front of base for No. 8 nut.

If surface mounting is desired, specify Nos. 4376-A and 4377-A which are equipped with terminal insulating covers. These covers are permanently hinged to the base and are readily snapped into a secure position after wiring.



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250 Volts
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SUPERIOR WIRING DEVICES

THE BRYANT ELECTRIC COMPANY
Bridgeport 2, Connecticut
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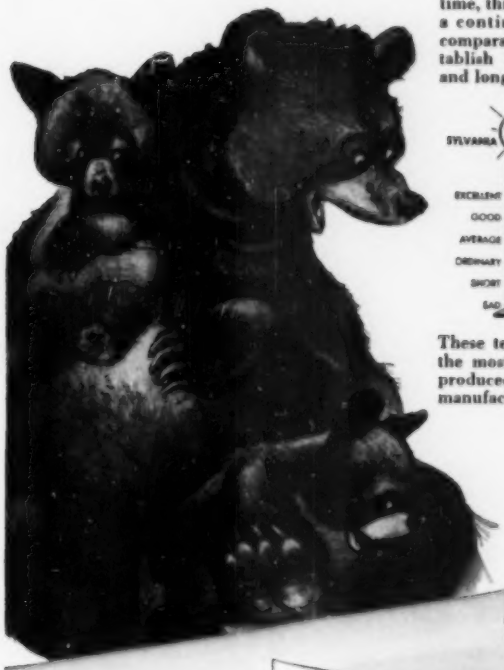
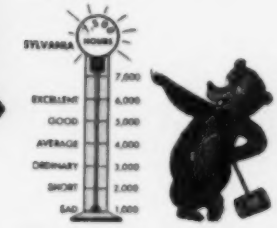
Lighting Troubles Hard to BEAR?
...Get Sylvania for "EXTRA LIFE"

2-YEAR TEST TELLS WHY SYLVANIA'S YOUR BUY!



Two years ago Sylvania Electric introduced an improved, longer-lasting fluorescent tube. Since that time, this company has conducted a continuing program of rigid comparative tests to definitely establish Sylvania's dependability and longer life.



These tests are being made with the most popular types of tubes produced by Sylvania and other manufacturers.

"EXTRA LIFE" FOR YOU

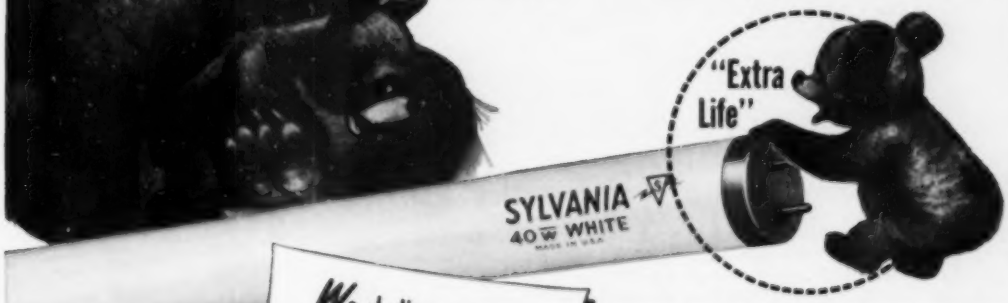
Of the many tubes tested, only Sylvania Tubes averaged 7500 hours. In terms of outstanding durability, this means that these Sylvania Fluorescent Tubes provided an "Extra Life" of from 2500 to 3000 hours . . . equivalent in offices and factories to an entire extra year of lighting life.

BRIGHTNESS MAINTAINED THROUGHOUT LIFE

In addition, the tests proved that Sylvania Fluorescent Tubes stay brighter.

Naturally, all test conditions for all tubes were identical. Continuing tests today show no deviation from the original findings.

For full information about the complete line of Sylvania Fluorescent Tubes and the savings they hold for you, mail the coupon today!



We challenge you to beat Sylvania Tubes for Long Life and Continued Brightness

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Please send me complete information about the life and brightness of Sylvania Fluorescent Tubes.

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FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; PHOTOLAMPS; TELEVISION SETS

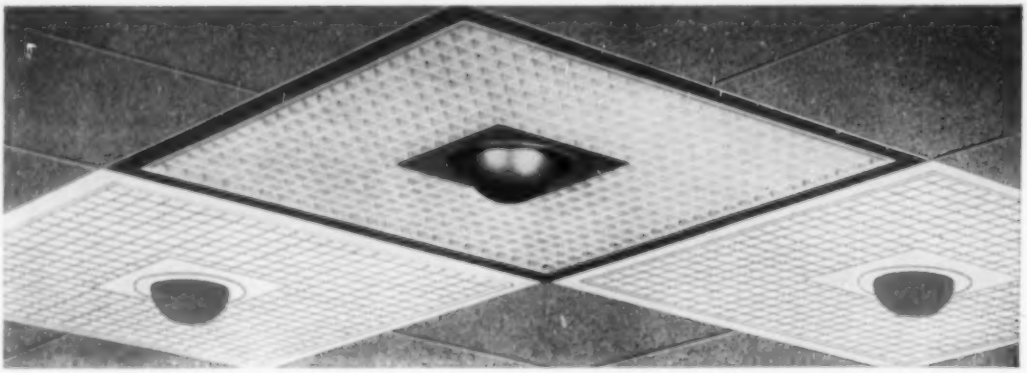
Orders for Skylike® are piling sky-high!

Silvray **SKYLIKE** lighting* – introduced only a couple of months ago – has excited everyone in the business: user, architect, contractor, lighting engineer. Orders and inquiries are coming in at a rate that has us jumping.

It's just our luck that **STEEL** has become as *hard to buy* as **SKYLIKE** is *easy to sell*. The Silvray Lighting purchasing department just can't find steel fast enough right now to catch up with the overnight-sensation popularity of this brilliant new concept of commercial lighting. You know the worthwhile reason, of course, so there's nothing to do but realize that Silvray **SKYLIKE** units will be produced – and orders will be filled – just as fast as conditions permit.

Meanwhile, for your future planning, we'll gladly send you a copy of the brochure, "Skylike Louvered Incandescent Lighting Systems". Write to *Room 1506, Graybar Electric Company, Inc., 420 Lexington Avenue, New York 17, N. Y.*

*Patent pending



Why so many businesses want Skylike

The **SKYLIKE** system combines the best features of silvered-bowl incandescent lighting with the architectural appeal of a fluorescent-type troffer. No other type of lighting has all its advantages! Here are some quick facts:

- Warm color—most desired by merchandising experts.
- High initial and maintained light output.
- Softly diffused shadows.
- Low brightness and 90° shielding.
- No flickering, blinking, or hum.
- Instant starting.
- Variable lamp size—150- to 500-watt.
- No light loss from darkened walls or ceilings.
- Floor-service relamping—no ladders or scaffolds.
- Hermetically sealed silver reflecting surface.
- Units fit 24" x 24" ceiling tiles, fully or partly recessed, or surface-mounted, in rows or patterns.
- Easily converted, with simple accessory, for directional or accent lighting.
- Simple in construction; simple in wiring; free of ballasts, starters, transformers.
- Lightweight; low-cost supporting construction.
- 87% reflection factor, easily maintained by occasional wiping with a damp cloth.
- Low-cost! ½ to ⅓ the cost of equipment delivering comparable results.

SILVRAY

Skylike

Distributed by Graybar Electric Company

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Glass
Corning ALBA-LITE

For Lighting That Sells—
Use CORNING ALBA-LITE

Here is a showroom lighting installation that is truly unique. With a light intensity of 82 foot candles and fixtures in an unusual radial pattern, it stands out day and night. To achieve this customer-attracting effect, Corning ALBA-LITE was specified.

Despite the high level of illumination in this installation, ALBA-LITE produces comfortable levels of panel brightness. Its non color selective properties assure that finishes are shown to best advantage. Even unlighted, the soft opal of ALBA-LITE presents an attractive appearance.

With an efficiency of over 90%, ALBA-LITE gives you maximum light transmission thereby reducing wattage requirements. Its smooth surface makes cleaning easy—keeps maintenance costs low. ALBA-LITE will not warp or sag in fixture frames and color transmission always remains true.

Available either flat or bent ALBA-LITE may be used for direct, semi-direct, semi-indirect and completely luminous ceiling. For complete information send for Bulletin LS-17.

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FOR EFFICIENT, ATTRACTIVE LIGHTING...

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Please send me a free copy of your Bulletin LS-17 describing Corning ALBA-LITE.

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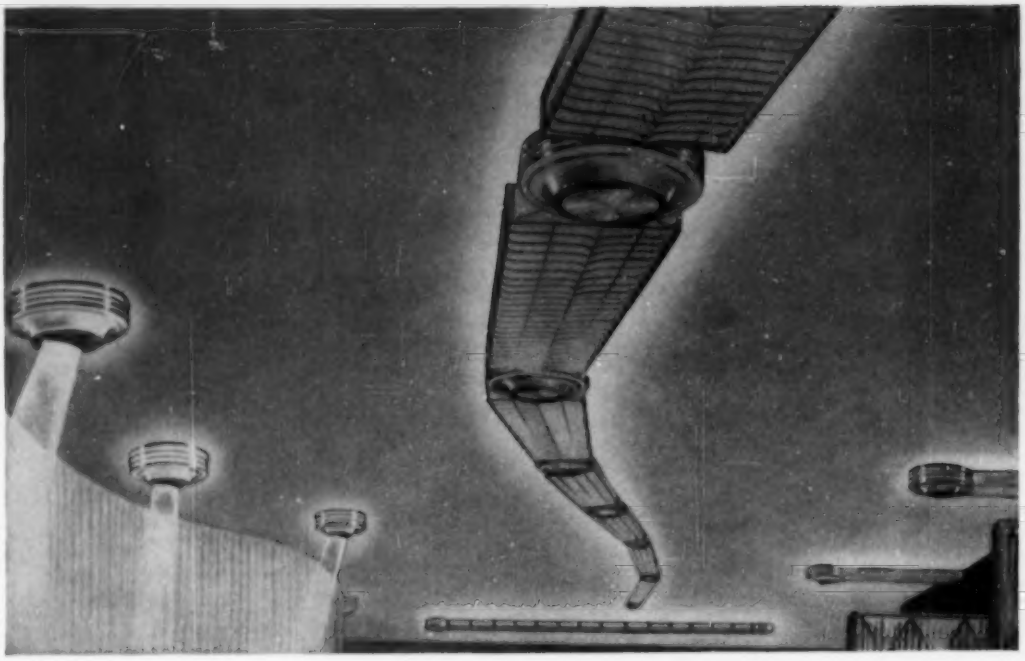
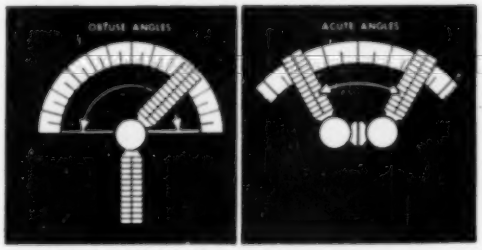


Now you can "do things" with lighting, too!

Buy PLEXOLINE!—sensational new mass-produced lighting system with "flexibility." Simple combinations of Plexoline's linear and circular units produce any lighting patterns your imagination can invent. Graceful curves of light . . . circular contours . . . angular patterns . . . abstract designs . . . and more!

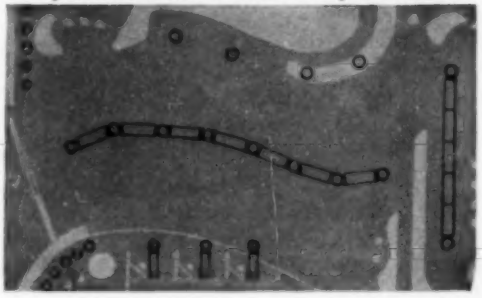
Best of all, Plexoline delivers this truly custom-tailored lighting *at standard cost*. It's modern lighting with all the traditional economies of Day-Brite QUALITY; Plexoline is carefully designed and produced to insure long years of trouble-free, efficient service at the *lowest* possible installation, maintenance and operating cost.

But you need the full PLEXOLINE story to properly judge its amazing advantages to you. Send for your free copy of "Plexoline — Imagination at Work." Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Mo. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.



Plexoline is simple. No intricate wiring arrangements, no costly installation problems. All parts are uniform, fit accurately. Linear sections are available in a variety of lengths, 2- and 4-lamp, Slimline and standard Fluorescent. Circular units available as adjustable accent units.

Now you Can DESIGN LIGHTING to Fit your Floor Plan!



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DAY-BRITE
Lighting Fixtures

PREMIUM QUALITY WITHOUT PREMIUM COST

unequalled ballast value

The Sola *"Sequenstart"* Ballasts have been proven by two years of successful use. The *"Sequenstart"* principle of wiring lamps in series makes possible continuous peak performance at minimum purchase, operating and maintenance costs. Sola *"Sequenstart"* Ballasts deliver optimum operating results with significant savings of presently critical materials. A complete line of Sola *"Sequenstart"* Ballasts are available to meet most lamp requirements.

Write for complete specifications on the Sola *"Sequenstart"* Ballasts to Department C.

SOLA *"Sequenstart"*

For Lenses and Filters
as YOU Want them . . .

KOPP GLASS

The engineering and manufacturing skill of the Kopp Glass organization guarantees lenses and filters as YOU want them. Colors are faithfully produced and accurately duplicated. Beam control designs give the results you desire, whether you want the light diffused, concentrated, spread or a combination of these. Kopp Glass lenses are dimensionally accurate and uniform.

Write for the 24-page bulletin which describes Kopp products and services.

KOPP GLASS, INC.

KOPP GLASS

SWISSVALE, PA.

QUIET MEANS QUALITY

The core and coil assembly of an Acme Electric Ballast is made to such a high standard of excellence that normal magnetic hum is minimized and then further silenced thru impregnation. Assembly is sealed in the case, solidly imbedded in heat and cold resisting compound. Noise free operation is assured.

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Acme Electric

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1950 TECHNICAL CONFERENCE

PROCEEDINGS

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Since it is probable that all of the Conference papers will not be published in full in ILLUMINATING ENGINEERING, this volume has been prepared for those Society members and others who wish the complete presentation for record or reference purposes.

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Continued on page 17A

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"low budget"

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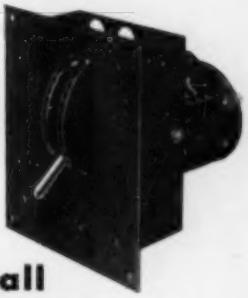
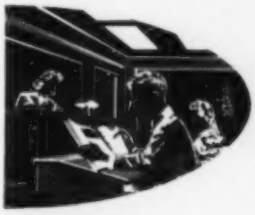
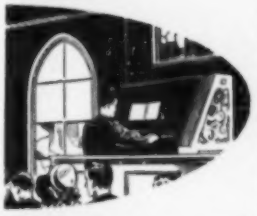
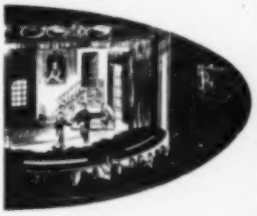
DIMMING
EQUIPMENT



- low cost
- easy to install
- simple to operate
- flexible in use







POWERSTAT

LIGHT DIMMING EQUIPMENT

Now light dimming equipment is within the reach of the many school, church, community, amateur and small theatre groups who operate on a low budget. POWERSTAT Dimmers are low in first cost, easy to install, inexpensive to operate and flexible in use. These Underwriters' Laboratories approved units efficiently convert power and do not dissipate it in the wasteful form of heat. They are flexible in that any number of lamps up to the rated capacity can be controlled.

Type D1000H, shown above, is a typical example of a low cost POWERSTAT Dimmer. It is the only unit of its size and cost with vertically operated handle and drum markings. It handles any load up to 1000 watts. Write for Bulletin 749 for information on the D1000H and other low cost POWERSTAT Dimmers.

Write 5110 Domara Avenue, Bristol, Connecticut

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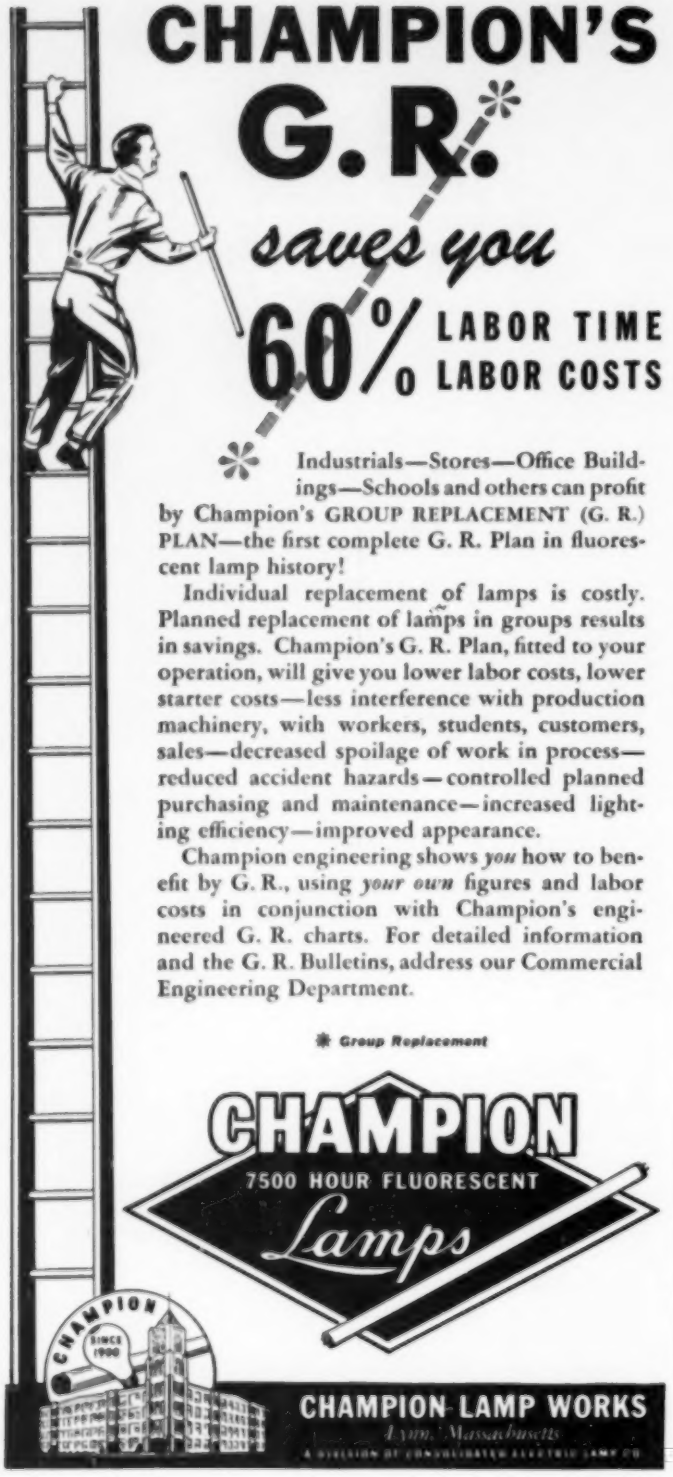
BRISTOL, CONNECTICUT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Individual replacement of lamps is costly. Planned replacement of lamps in groups results in savings. Champion's G. R. Plan, fitted to your operation, will give you lower labor costs, lower starter costs—less interference with production machinery, with workers, students, customers, sales—decreased spoilage of work in process—reduced accident hazards—controlled planned purchasing and maintenance—increased lighting efficiency—improved appearance.
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INDEX TO ADVERTISERS
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Acme Electric Corp.	14A
Benjamin Electric Mfg. Co.	Inside Front Cover
Bryant Electric Co.	8A
Champion Lamp Works	16A
Corning Glass Works	11A
Curtis Lighting Inc.	4A
Day-Brite Lighting Inc.	12A
General Electric Co., Lamp	6A
Graybar Electric Co. Inc.	10A
Edwin F. Guth Co.	17A
Kopp Glass Inc.	14A
Litecontrol Corp.	2A
Pittsburgh Reflector Co.	5A
R.L.M. Standards Institute	Inside Back Cover
Sola Electric Co.	13A
Sunbeam Lighting Co.	18A
Superior Electric Co.	15A
Sylvania Electric Products Inc.	9A
F. W. Wakefield Brass Co.	7A
Westinghouse Electric Corp., Lamps	Back Cover
Westinghouse Electric Corp., Lighting	1A
Wiremold Co.	18A

Continued from page 15A

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Skaggs, A. D., Oklahoma Gas & Elec. Co., Oklahoma City
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by Pennsylvania manufacturer for work in "sales-service" type laboratory. Interested in optics, illumination, photometry, insulation, heating, air conditioning, ventilation, building construction, architecture; experienced in designing, assembling, calibrating and using application laboratory equipment. Mature, self-reliant, practical; technical-minded but must also appreciate promotional problems. Able to do and direct all jobs in laboratory, including routine, and to establish procedures for product performance tests. Interviews will be arranged. Send details, references and salary required to Box 136, Illuminating Engineering Society, Publications Office, 51 Madison Ave., New York 10, N. Y.

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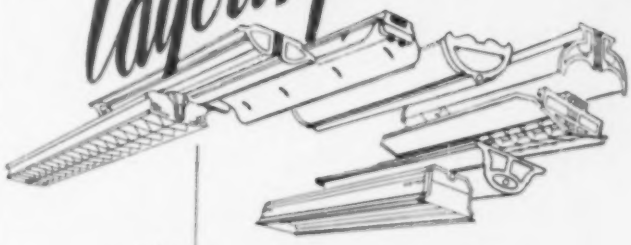
layout possibilities*



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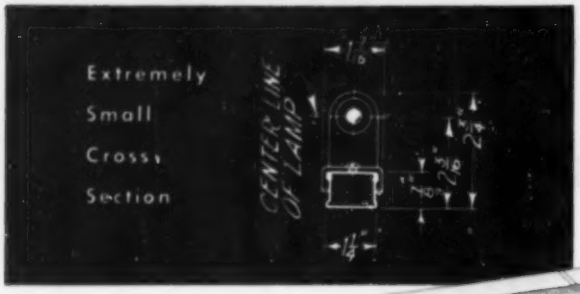

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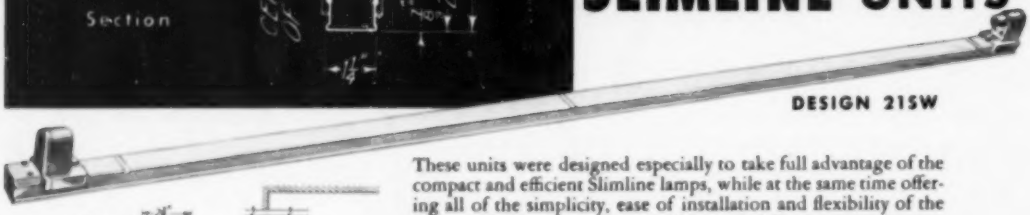
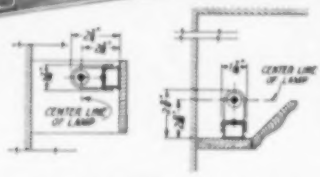
DESIGN 215W



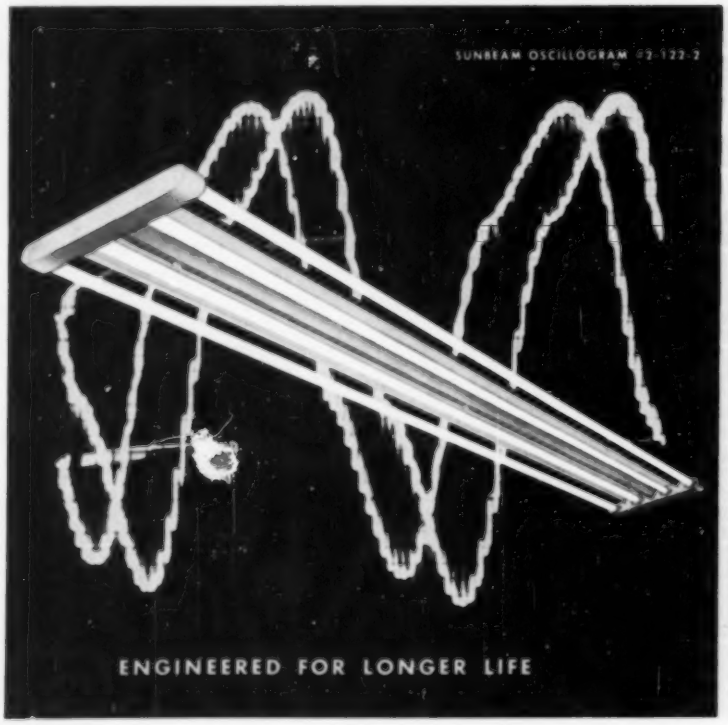


These units were designed especially to take full advantage of the compact and efficient Slimline lamps, while at the same time offering all of the simplicity, ease of installation and flexibility of the Wiremold No. 2100 raceway. Note especially the compact cross section, ideal for special cove and valance effects. Remotely located ballasts are a great advantage in most installations of this kind, saving space and eliminating noise. Wiremold supplies convenient ballast boxes and connections are easily made. Write for further details or consult your Electrical Contractor.

THE WIREMOLD COMPANY • HARTFORD 10, CONNECTICUT

- WIRED and ASSEMBLED
- EASILY INSTALLED and CONNECTED
- WHITE ENAMEL FINISH
- FOR USE WITH REMOTELY LOCATED BALLAST
- UNIT OR CONTINUOUS STRIP INSTALLATION

12WM50



The controlled selection of ballasts in Sunbeam's own laboratory assures the customer of longer slimline lamp life through low crest factor. This means fewer lamp replacements and lower maintenance costs. Combining this with the 90% efficiency (ceiling mounted) of Sunbeam's open type, slimline 1300 series fixtures, makes it possible to specify these units as one of the most practical and economical light sources for markets, stores and low ceiling work areas. All slimline lamp lengths and milliamp ratings, including the 48" T-12 430 MA, are available in this series.

SUNBEAM LIGHTING COMPANY

777 E. 14TH PLACE

LOS ANGELES 21, CALIF.

another aid to
BETTER PLANNED LIGHTING

Everyone who specifies, recommends, buys or sells industrial lighting equipment should have a copy of the new RLM Bulletin 1050. This bulletin brings you an up-to-date check list of all manufacturers of RLM-labeled lighting units and the types of RLM-certified units made by each. It is intended to facilitate the specification of quality lighting units so essential to the success of any Planned Lighting Program.

Featuring an easy-to-use chart, the bulletin enables you to quickly determine: (1) whether or not a certain size and type of unit is RLM certified; (2) the names of all manufacturers who make RLM-labeled units of the type and size desired; (3) the names of manufacturers and the types of lighting units which they currently have on submittal to the Electrical Testing Laboratories for test and certification.

The bulletin supplements the RLM SPECIFICATIONS BOOKLET which contains all RLM Specifications in effect as of March, 1950. When used in conjunction with the Specifications Booklet, the bulletin will prove of important assistance in the procurement of lighting equipment that meets nationally recognized standards of quality and performance.

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RS245

THE WESTINGHOUSE FLUORESCENT SUN LAMP

. . . FIRST OF ITS KIND
. . . AND FAST BECOMING
FIRST FOR INDOOR SUNSHINE

Tried, tested, and accepted! That's what has happened since Westinghouse introduced its exclusive *Fluorescent* Sun Lamp a year ago. And with this first year's success, the sales future for this lamp looks brighter than ever.

There are good reasons for this acceptance. For the first time, wide areas can be bathed practically and economically with beneficial ultraviolet rays. At a relatively close range, it's ideal for tanning. Cool enough to touch, it has five times the output and four times the life of the conventional bulb-type sun lamp. It costs less to buy, less to run, and fits standard fluorescent fixtures. The market for this lamp is all around you . . . homes, offices, factories, schools, recreation centers, barber shops, beauty shops, to name a few . . . and this is *additional* business, not substitute business!

Why not cash in on this lamp's new business opportunities? *Now* is the time because Westinghouse is now launching a heavy advertising program for the sun lamp. Mail the coupon today, and we'll tell you how to tie in with a really good thing!

TECHNICAL DATA

	20-WATT LAMP	40-WATT LAMP
Bulb diameter	1½"	1½"
Lamp Length	24"	48"
Base	Medium Bipin	Medium Bipin
List Price	$4.50	$7.00

Rated Avg. Life: 2500 hours at 3 hours per start
9000 hours at 6 hours per start
5000 applications of 15 minutes per start

YOU CAN BE SURE . . . IF IT'S

Westinghouse

Lamp Division
Westinghouse Electric Corporation
Bloomfield, New Jersey

Gentlemen:
Please send your booklet on the Westinghouse Fluorescent Sun Lamp, and give me any additional information about this lamp's market possibilities.

NAME .....

ADDRESS .....

CITY ..... STATE .....